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THE ALASKO-CANADIAN FRONTIER.*

By THOMAS WILLING BALCH.

At the end of May, 1898, the United States and Great Britain agreed to appoint an Anglo-American Joint High Commission to consider and arrange upon a basis more favorable to both sides, such important problems as the regulations of the North Atlantic fisheries, commercial reciprocity and the Behring Sea fishery question. Soon after, "For the first time a statement was presented by the British Government to the Government of the United States on the 1st of August, 1898, developing the fact that a difference of views existed respecting the provisions of the treaty of 1825" between the United States and the English Empire, concerning the meaning of the Alaska

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frontier as defined in the Anglo-Russian treaty of 1825;[1] and on August 23d the British Government claimed that the eastern boundary of Alaska should run from the extremity of Prince of Wales Island at 54° 40′, along the estuary marked on recent maps as Pearse Canal, up to the top of the Portland Canal, from there straight to the coast and then along the mountains on the mainland nearest to the shore and across all the sinuosities of the sea that advance into the continent up to Mount Saint Elias.[2] (See map, Plate I.)

By the treaty negotiated at Saint Petersburg and signed there on February 16–28, 1825, the Muscovite and the British Empires agreed in Articles III and IV of that treaty upon the following divisional line between their respective North American possessions.[3]

"ARTICLE III.

"The line of demarcation between the possessions of the High Contracting Parties upon the coast of the continent, and the islands of America to the northwest, shall be drawn in the manner following:

"Commencing from the southernmost part of the island called Prince of Wales Island, which point lies in the parallel of 54° 40′ north latitude, and between the 131st and the 133rd degree of west longitude (meridian of Greenwich), the said line shall ascend to the north along the channel called Portland Channel, as far as the point of the continent

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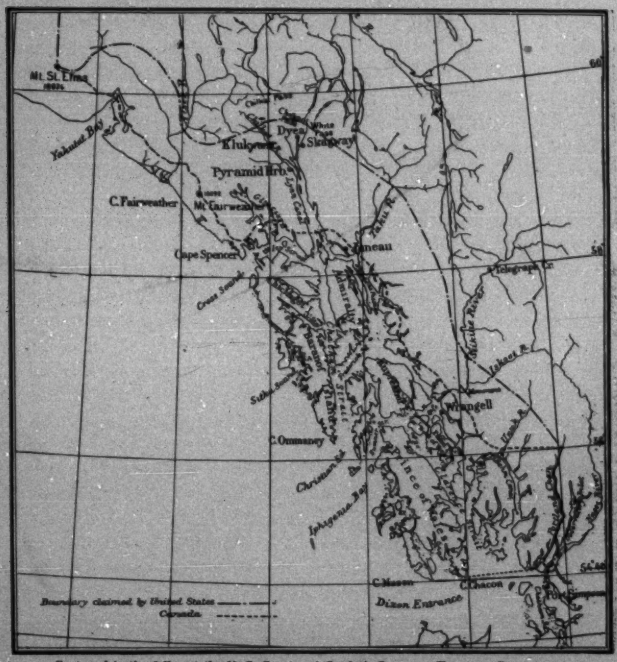
[1] "The Alaskan Boundary," by Hon. John W. Foster: *The National Geographic Magazine*, November, 1899: Washington, p. 453. Mr. Foster, the able author of this article, was Secretary of State, 1892–93, in the Harrison Administration, and has been from the beginning one of the United States members of the Joint High Commission.

In collecting maps on the subject of the Alaskan frontier, I have received kind aid from Mr. P. Lee Phillips, chief of the Map Division of the Library of Congress, and Mr. Tittman and Mr. Andrew Braid, of the United States Coast and Geodetic Survey, at Washington, D. C.

[2] "The Alaskan Boundary," by Hon. John W. Foster: *The National Geographic Magazine*, November, 1899: Washington, p. 455.

[3] "Fur Seal Arbitration." Washington, Government Printing Office 1895; Vol. IV, pp. 42–43.

where it strikes the 56th degree of north latitude; from this last-mentioned point, the line of demarcation shall follow the summit of the mountains situated parallel to the coast, as far as the point of intersection of the 141st degree of west longitude (of the same meridian); and finally, from



Prepared in the Office of the U. S. Coast and Geodetic Survey. Treasury Department.

PLATE I—United States and English boundary claims.

the said point of intersection, the said meridian line of the 141st degree, in its prolongation as far as the Frozen Ocean, shall form the limit between the Russian and British possessions on the continent of America to the northwest.

"ARTICLE IV.

"With reference to the line of demarcation laid down in the preceding Article, it is understood:

"1st. That the island called Prince of Wales Island shall belong wholly to Russia.

"2nd. That wherever the summit of the mountains which extend in a direction parallel to the coast, from the 56th degree of north latitude to the point of intersection of the 141st degree of west longitude, shall prove to be at a distance of more then 10 marine leagues from the ocean, the limit between the British possessions and the line of coast which is to belong to Russia, as above mentioned, shall be formed by a line parallel to the windings [*sinuosités*] of the coast, and which shall never exceed the distance of 10 marine leagues therefrom."[4]

The negotiations that resulted in the treaty of 1825 were originated by an Ukase promulgated in 1821 by Emperor Alexander the First, in which, in addition to claiming exclusive jurisdiction for Russia in the waters of Behring Sea and a large part of the northern part of the Pacific Ocean, he extended also the territorial claims of Russia from the 55°, as claimed by the Ukase of 1799 issued by the Emperor Paul, down to the 51° of north latitude. The United States and Great Britain both protested against the pretensions of sovereignty asserted in the Ukase of 1821. In 1824 the United States and the Russian Governments signed a treaty in which, among other things, they agreed on the parallel of 54° 40′ as the divisional line between their respective territorial claims; all below that line Russia agreed to leave to the United States to contest with Great Britain, and all above it the United States consented to leave to Russia to dispute with England.

[4] Owing to the importance of the French text, which the British Government in its printed argument in the Bering Sea Seal Fisheries Case (*Fur Seal Arbitration*, Vol. IV, p. 500) recognized as the official version, and the fact that French is the diplomatic language of the world, which was probably much more the case in 1825 than to-day, the French text is given here:

"ARTICLE III.

"La ligne de démarcation entre les possessions des Hautes Parties Contractantes sur la côte du continent et les îles de l'Amérique nord-ouest, sera tracée ainsi qu'il suit :

Meanwhile, the course of negotiations between Russia and England did not progress as smoothly; but finally in February, 1825, nearly a year after the signing of the Russo-American Treaty, the Russian and the English plenipotentiaries signed the treaty containing the two articles above quoted. For more than half a century the British Empire never contested the interpretation openly placed by both the Muscovite and the United States Governments that under those two articles, first Russia and later—after the cession of Russian America or Alaska in 1867 to the American Union—the United States were entitled to a strip of territory (*lisière*) on the mainland from the Portland Channel or Canal in the south up to Mount Saint Elias in the north, so as to cut off absolutely the British possessions from access to the sea above the point of 54° 40′. In August, 1898, for the first time, the British Empire formally claimed at the Quebec Conference that the proper reading of those two articles entitled Canada to the upper part of most or all of the fiords between the Portland Canal and Mount Saint Elias.[5]

"A partir du point le plus méridional de l'île dite Prince of Wales, lequel point se trouve sous le parallèle du 54e degré 40 minutes de latitude nord, et entre le 131e et le 133e degré de longitude ouest (méridien de Greenwich), la dite ligne remontera au nord le long de la passe dite Portland Channel, jusqu'au point de la terre ferme où elle atteint le 56e degré de latitude nord; de ce dernier point la ligne de démarcation suivra la crête des montagnes situées parallèlement à la côte, jusqu'au point d'intersection du 141e degré de longitude ouest (même méridien); et, finalement, du dit point d'intersection, la même ligne méridienne du 141e degré formera, dans son prolongement jusqu'à la Mer Glaciale, la limite entre les possessions Russes et Britanniques sur le continent de l'Amérique nord-ouest.

"ARTICLE IV.

"Il est entendu, par rapport à la ligne de démarcation déterminée dans l'Article précédent:

"1. Que l'île dite Prince of Wales appartiendra toute entière à la Russie.

"2. Que partout où la crête des montagnes qui s'étendent dans une direction parallèle à la côte depuis le 56e degré de latitude nord au point d'intersection du 141e degré de longitude ouest, se trouveroit à la distance de plus de 10 lieues marines de l'océan, la limite entre les possessions Britanniques et la lisière de côte mentionnée ci-dessus comme devant appartenir à la Russie, sera formée par une ligne parallèle aux sinuosités de la côte, et qui ne pourra jamais en être éloignée que de 10 lieues marines."

[5] "The Alaskan Boundary," by Hon. John W. Foster; *The National Geographic Magazine*, November, 1899: Washington, p. 453.

A review of the negotiations during the years 1822, 1823, 1824 and 1825, between Count Nesselrode and M. de Poletica in behalf of Russia, and first of Sir Charles Bagot and afterwards of Mr. Stratford Canning, later Lord Stratford de Redcliffe, for Great Britain, shows clearly that the

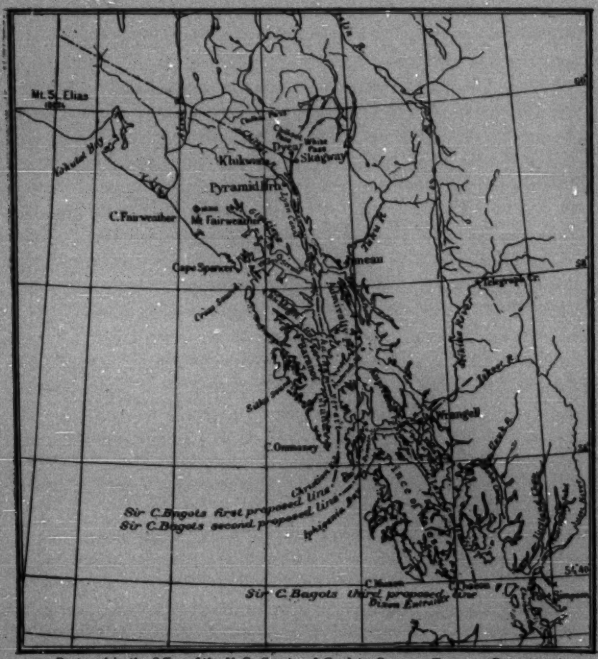


PLATE II.—Sir C. Bagot's three proposed boundaries, 1824.

agreement finally reached as embodied in the treaty of 1825 was to exclude the British North American territory from all access to the sea above the point of 54° 40′. From the very inception of the negotiations, the Russians insisted

upon the possession for Russia of a strip or *lisière* on the mainland from the Portland Channel up to Mount Saint Elias expressly to shut off England from access to the sea at all points north of the Portland Canal. Sir Charles Bagot, on behalf of England, fought strenuously to keep open a free access to the sea as far north above the line of 54° 40′ as possible (Plate II). First, he proposed that the line of territorial demarcation between the two countries should run "through Chatham Straits to the head of Lynn Canal, thence northwest to the 140th degree of longitude west of Greenwich, and thence along that degree of longitude to the Polar Sea."[6] To this Count Nesselrode and M. de Poletica replied with a *contre-projet* in which they proposed that the frontier line, beginning at the southern end of Prince of Wales Island, should ascend the Portland Canal up to the mountains; that then from that point it should follow the mountains parallel to the sinuosities of the coast up to the 139th degree of longitude west from Greenwich, and then follow that degree of longitude to the north.[7]

At the next conference Sir Charles Bagot gave Count Nesselrode and M. de Poletica a written modification of his first proposition. In this new proposal he first stated that the frontier that they demanded would deprive Great Britain of sovereignty over all the *anses* and small bays that lie between 56° and 54° 40′ of latitude, and that owing to the proximity of these fiords and estuaries to the interior posts of the Hudson's Bay Company, they would be of essential importance to the commerce of that company; while on the other hand, the Russian-American Company had posts neither on the mainland between those degrees of latitude, nor even on the neighboring islands. Sir Charles proposed that the line of separation should pass through "the middle of the canal that separates Prince of Wales Island and Duke of York Island from all the islands situated to the north of the said islands until it [the line] touches the mainland." Then advancing in the same direction to the east for ten marine leagues, the line should then

[6] "Fur Seal Arbitration," Vol. IV, p. 424.
[7] "Fur Seal Arbitration," Vol. IV, p. 427.

ascend towards the north and northwest, at a distance of ten marine leagues from the shore, following the sinuosities of the coast up to the 140° of longitude west from Greenwich and then up to the north.[8]

At the next conference the Russian plenipotentiaries again insisted upon their original proposal that the frontier line should ascend the Portland Canal and then follow the mountains bordering the coast line.

Sir Charles Bagot then brought forward a third boundary line that, passing up Duke of Clarence Sound and then running from west to east along the straits separating Prince of Wales Island and Duke of York Island to the north, should then advance to the north and the northwest in the way already proposed.[9]

But again the Russian diplomates insisted on their original proposition. On April 17, 1824, Count Nesselrode addressed to Count Lieven, the Russian Ambassador at London, a long and exhaustive review of the negotiations with Sir Charles Bagot, and instructed Count Lieven to press the Russian views upon the English Cabinet. In that communication, after speaking of Russia's declaration at the beginning of the negotiations that she would not insist upon the claim to the territory down to the 51° put forward in the Ukase of 1821, and that she would be content to maintain the limits assigned to Russian America by the Ukase of 1799, he went on to say "that consequently the line of the 55th degree of north latitude would constitute upon the south the frontier of the States of His Imperial Majesty, that upon the continent and towards the east this frontier could run along the mountains that follow the sinuosities of the coast up to Mount Saint Elias, and that from that point up to the Arctic Ocean we would fix the limits of the respective possessions according to the line of the 140th degree of longitude west from Greenwich.

"In order not to cut Prince of Wales Island, which according to this arrangement should belong to Russia, we proposed to carry the southern frontier of our domains to the

[8] "Fur Seal Arbitration," Vol. IV, p. 428.
[9] "Fur Seal Arbitration," Vol. IV, p. 430.

54° 40′ of latitude and to make it reach the coast of the continent at the Portland Canal whose mouth opening on the ocean is at the height of Prince of Wales Island, and whose origin is in the lands between the 55° and 56° of latitude."

Russia, by limiting her demands to those set forth in the Ukase of 1799, simply defended claims against which, for over twenty years, neither England nor any other power had ever made a protest. England, on the contrary, sought to establish her right to territory which she had thus passively recognized as Russian, and which lay beyond any of her settlements. Count Nesselrode contrasted the policy of the two states in a pithy sentence: "Thus we wish to retain, and the English Companies wish to acquire."

The negotiators were thus brought face to face with their rival claims. The Russians insisted, on the one hand, that they must have possession of a *lisière* or strip of territory on the mainland in order to support the Russian establishments on the islands and to prevent the Hudson's Bay Company from having access to the sea and forming posts and settlements upon the coast line opposite to the Russian Islands; while Sir Charles Bagot maintained, on the other hand, that Great Britain must have such part of the coast and inlets north of 54° 40′ as would enable the English Companies and the settlements back from the coast to have free access to the fiords and estuaries opening into the ocean.

After a few months, Mr. George Canning, the English Foreign Secretary, instructed Sir Charles Bagot to agree to the Portland Channel as part of the frontier line; but with the reservation, first, that the eastern line of demarcation should be so defined as to guard against any possibility, owing to subsequent geographical discoveries, that it could be drawn at a greater distance from the coast than ten marine leagues, and secondly, that the harbor of Novo-Archangelsk (now Sitka) and the rivers and creeks on the continent should remain open forever to British commerce.

During the course of the new negotiations between Count Nesselrode and M. de Poletica in behalf of Russia, and of Sir Charles Bagot for England, the second of these

two points was the main object of discussion. Sir Charles was unable to conclude a treaty with the Russian diplomates, for the latter refused to agree to open forever the port of Novo-Archangelsk to British commerce. Neither were they willing to grant to the subjects of England the right *forever* to navigate and trade along the coast of the *lisière* that it was proposed Russia should have. The British Ambassador, realizing that it was impossible for him to negotiate a treaty in accordance with his instructions, soon thereafter left Saint Petersburg.

In the latter part of the year 1824, Great Britain appointed Mr. Stratford Canning, later Lord Stratford de Redcliffe, one of the ablest of her diplomates, to continue the negotiations left unfinished between Sir Charles Bagot, and Count Nesselrode and M. de Poletica. When Canning took up the negotiations, Great Britain had receded from all contentions except as to the width of the *lisière*. In his instructions he received power to arrange for a line of demarcation that should run along the crest of the mountains, except where the mountains were more than ten marine leagues from the shore, in which case the frontier should follow, at a distance of ten marine leagues inland, the sinuosities of the shore. With these new instructions Stratford Canning was able to conclude a treaty to which Sir Charles Bagot could not have agreed. And on the 16/28 of February, 1825, Stratford Canning on behalf of Great Britain, and Count Nesselrode and M. de Poletica for Russia, signed a treaty definitely dividing Canada and Russian-America.

George Canning, towards the end of his instructions to Stratford Canning, showed what was the chief motive of England in the pending negotiations with Russia. He wrote:

"It remains only in recapitulation to remind you of the origin and principles of this whole negotiation.

"It is *not* on our part essentially a negotiation about limits.

"It is a demand of the repeal of an offensive and unjustifiable arrogation of exclusive jurisdiction over an ocean of unmeasured extent; but a demand qualified and miti-

gated in its manner, in order that its justice may be acknowledged and satisfied without soreness or humiliation on the part of Russia.

"We negotiate about territory to cover the remonstrance upon principle.

"But any attempt to take undue advantage of this voluntary facility we must oppose."[10]

Thus the chief concern of the English Government was to obtain from that of Russia an official disclaimer of the assertion in the Ukase of 1821 that the waters of Behring Sea and parts of the northern Pacific were exclusively Russian waters. Russia would not assent to formally recognize the right of English ships freely to navigate those seas, unless the boundary question was also arranged and settled so as to insure to Russia an unbroken *lisière* from the Portland Canal up to Mount Saint Elias. And on this last point England, after a long and stubborn resistance, finally yielded.

Much of the trouble that the negotiators of the Anglo-Muscovite treaty of 1825 had in agreeing upon the eastern boundary of the *lisière* was due to a lack of knowledge respecting the mountains along the northwest American coast. According to Vancouver's chart and other available information, a mountain range ran along the coast not far from the sea. When Stratford Canning and Count Nesselrode and M. de Poletica finally agreed upon the mountain divide as the frontier between the two nations, Canning, acting upon instructions from his cousin, George Canning, who was British Secretary of Foreign Affairs, insisted that should the summit of the mountains prove to be at any point more than ten marine leagues from the shore, then the line of demarcation should be drawn parallel to the *sinuosities* of the shore at a distance of ten marine leagues. This ten-league limit to the eastward was inserted on purpose, as George Canning stated in his instructions to Stratford Canning, to guard England against a possibility of having her territory pushed back to the eastward a hundred miles or more from the sea in case the crest of the mountains

[10] "Fur Seal Arbitration," Vol. IV, p. 448.

was found in reality to lie far back from the coast instead of close to it, as was then supposed.

Thus a review of the negotiations that culminated in the Anglo-Muscovite treaty of 1825 shows clearly that the negotiators of that treaty intended to include within the Russian territory a *lisière* on the mainland, stretching from the Portland Canal in the south up to Mount Saint Elias in the north, and extending between those points far enough inland to exclude the English possessions absolutely from access to the coast line above 54° 40′.

The treaty was drawn in French, and an English copy was also prepared. In the French version, the language of diplomacy,[11] it is said that the inland frontier of the *lisière* shall be a line drawn "parallèle aux *sinuosités* ['windings' in the English version] de la côte." The meaning of the phrase is made absolutely clear by the use of the word *sinuosités*. Littré, who was a member of *l'Académie Française*, defines, in his *Dictionnaire de la Langue Française*, "sinuosités" as meaning: "Qualité de ce qui est sinueux. Cette rivière fait beaucoup de sinuosités. Il allait dans une chaloupe avec deux ingénieurs côtoyer les deux royaumes de Danemark et de Suéde, pour mesurer toutes les sinuosités, Font. Czar Pierre. Les Jeunes Déliens se mêlèrent avec eux (les Anthéniens) pour figurer les sinuosités du labyrinthe de Crète, Barthél. Anach. ch. 76."[12] Webster defines *sinuosity* to mean: "1. The quality of being sinuous, or bending in and out. 2. A series of bends and turns in arches or other irregular figures; a series of windings. 'A line of coast certainly amounting with its *sinuosities* to more than 700 miles.' S. Smith."[13]

Thus the use of the word *sinuosités*, independently of all other evidence, shows that the negotiators of the treaty

[11] "Fur Seal Arbitration," Vol. IV, p. 500 *et seq.*

"Principes du Droit des Gens," par Alphonse Rivier: Paris, 1896, Vol. II, p. 19.

"Introduction to the Study of International Law," by Theodore D. Woolsey: New York, 1888, fifth edition, p. 270.

[12] Littré, Paris, Hachette et Cie, 1873.

[13] "An American Dictionary of the English Language," revised by Professors Goodrich and Porter of Yale; Springfield, Mass., 1876.

meant to include within the Russian *lisière* the whole of the Lynn Canal and all other fiords above the Portland Canal.

Aside, however, from the manifest intent of the negotiators as thus revealed, the meaning and understanding of both the British and the Russians as to the definite frontier for which they arranged between their respective empires in the treaty of 1825 is conclusively proved; *first*, by the overwhelming multitude of maps of the best cartographers of the various leading powers of the world, including those of England and Canada, in sustaining the boundary always claimed in the beginning by Russia and afterwards by the United States; *secondly*, by the acts of the British and the Canadian authorities until well towards the close of the nineteenth century.

In the year 1825, shortly after the treaty defining the frontier between Russian and British North America became known, A. Brué, one of the leading French cartographers, published at Paris a map entitled: "Carte de l'Amérique Septentrionale; Redigée par A. Brué, Géographe du Roi; Atlas Universel, Pl. 38." On this map Brué drew the boundary of Russian America on the continent from the top of the Portland Canal at the distance of ten marine leagues from tide water round all the sinuosities up to the 141° of longitude, and then along that meridian to the north. Two years later, in 1827, the celebrated Russian Admiral and navigator, A. J. de Krusenstern, published at Saint Petersburg, "par ordre de Sa Majesté Impériale," a "Carte Générale de l'Ocean Pacifique, Hemisphère Boréal." (Plate III). Krusenstern drew on the mainland the frontier of Russian America from the top of the Portland Canal round the sinuosities of the shore at a distance of ten marine leagues from tide water up to the 141° and then northward along that meridian. Along the line of the 141° is inscribed, "Limites des Possessions Russes et Anglaises d'après le Traité de 1825." Two years later, in 1829, there appeared at Saint Petersburg a map of the eastern extremity of Siberia and the northwest coast of America. This map was "No. 58ª (b)" of the "Atlas Géographique de l'Empire de Russie," etc., that was prepared by Function-

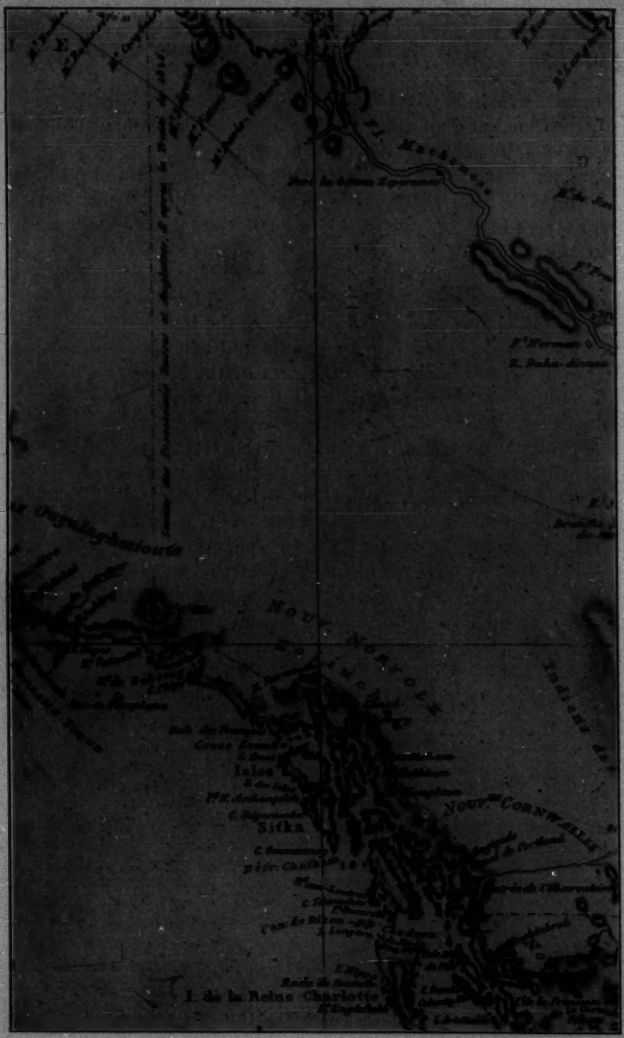


PLATE III.—Imperial Russian map: "Dressé par M. de Krusenstern, Contre-Amiral * * * publié par ordre de Sa Majesté Impériale. Saint Petersbourg, 1827."

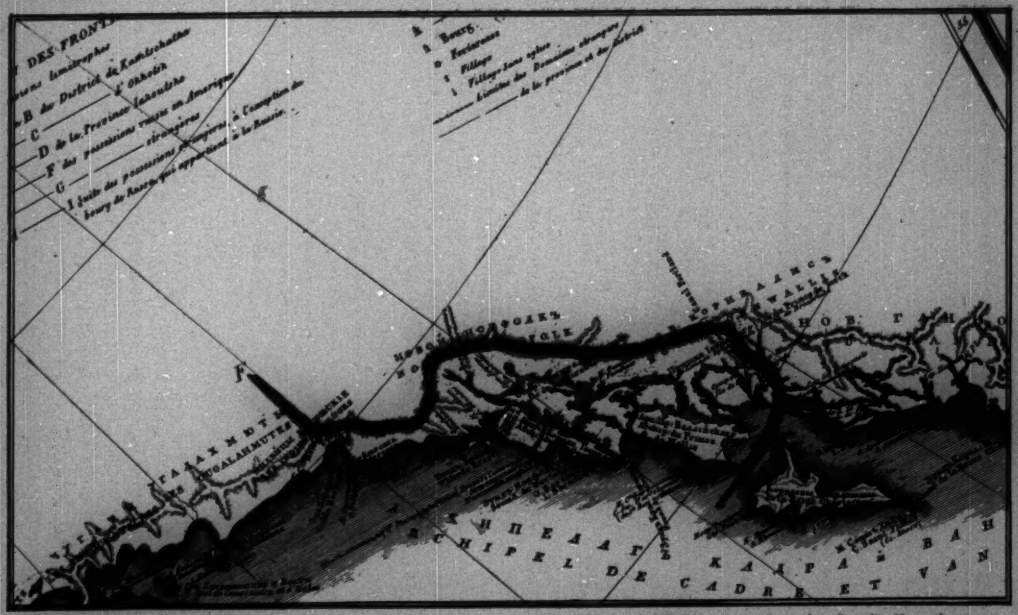


PLATE IV.—"Carte Générale * * * de la côte N. W. de l'Amérique," prepared at St. Petersburg in 1829, by Functionary Pladischeff "au Dépôt Topographique militaire."

ary Piadischeff. On this map, Piadischeff drew the Russo-British frontier from Mount Saint Elias down to the top of the Portland Canal and then along that sinuosity down to the sea at 54° 40′, thereby shutting off Britain from access to the sea above 54° 40′. (Plate IV).[14]

The British Government made no protest against the way Krusenstern and Piadischeff had marked the boundary. On the contrary, a few years later, in 1831, a map was prepared by Joseph Bouchette, Jr., "Deputy Surveyor General of the Province of Lower Canada," and published the same year at London by James Wyld, geographer to the King, and "with His Majesty's most gracious and special permission most humbly and gratefully dedicated * * * to His Most Excellent Majesty King William IVth * * * * * compiled from the latest and most approved astronomical observations, authorities, and recent surveys." (Plate V). It reaffirmed the boundary as given upon Krusenstern's imperial map. Again, in a "Narrative of a Journey Round the World, during the years 1841 and 1842, by Sir George Simpson, Governor-in-chief of the Hudson's Bay Company's Territories in North America," published at London in 1847,[15] a map in Volume I, showing the author's route, gives the line of demarcation between the Russian and the English territories as it was laid down by Krusenstern in his map of 1827. (Plate VI).

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[14] See map, Plate IV. Map "No. 60ª (a)" of the atlas is entitled, "Carte Générale de l'Empire de Russie," etc. This is a map of the whole Russian Empire in 1829, and in the left-hand lower corner the boundary of the Russian-American *lisière* is given as on map "No. 58." Charles Sumner used this general map of the Empire, "No. 60," in preparing his speech in support of the purchase of Alaska in 1867. The copy that he used is now in the Harvard Library. The reproduction of map "No. 58" in this paper was made from a copy of Piadischeff's Atlas, now in possession of the writer, that belonged originally to Prince Alexander of Hesse, a brother of the Empress, Alexander the Second of Russia. The titles and nomenclature of the atlas are given both in Russian and French. The French title is: "Atlas Géographique de l'Empire de Russie, du Royaume de Pologne et du Grand Duché de Finlande * * * * par le Fonctionnaire de la 6ª Classe Piadischeff, employé au Dépot Topographique militaire dans l'Etat-Major de Sa Majesté Impériale: Commencé en 1820 et terminé en 1827, revu et corrigé en 1834.

[15] London: Henry Colburn, 1847; there is a copy of this work in the British Museum.

PLATE V.—Canadian map of 1831: "Compiled * * * by Joseph Bouchette, Jr., Deputy Surveyor General of the Province of Lower Canada."

Ten years later, in 1857, an investigation into the affairs of the Hudson's Bay Company was held by a special committee of the House of Commons. At that investigation, Sir George Simpson, who was examined, presented a map of the territory in question, and, speaking for the Company, said: "There is a margin of coast, marked yellow on the

PLATE VI.—Map in "Narrative of a Journey Round the World," by Sir George Simpson, London, 1847.

map, from 54° 40′ up to Cross Sound which we have rented from the Russian Company." (Plate VII). This map shows that the strip of land on the continent extended far enough inland to include all the sinuosities of the coast so as to exclude, according to the United States claims, the British

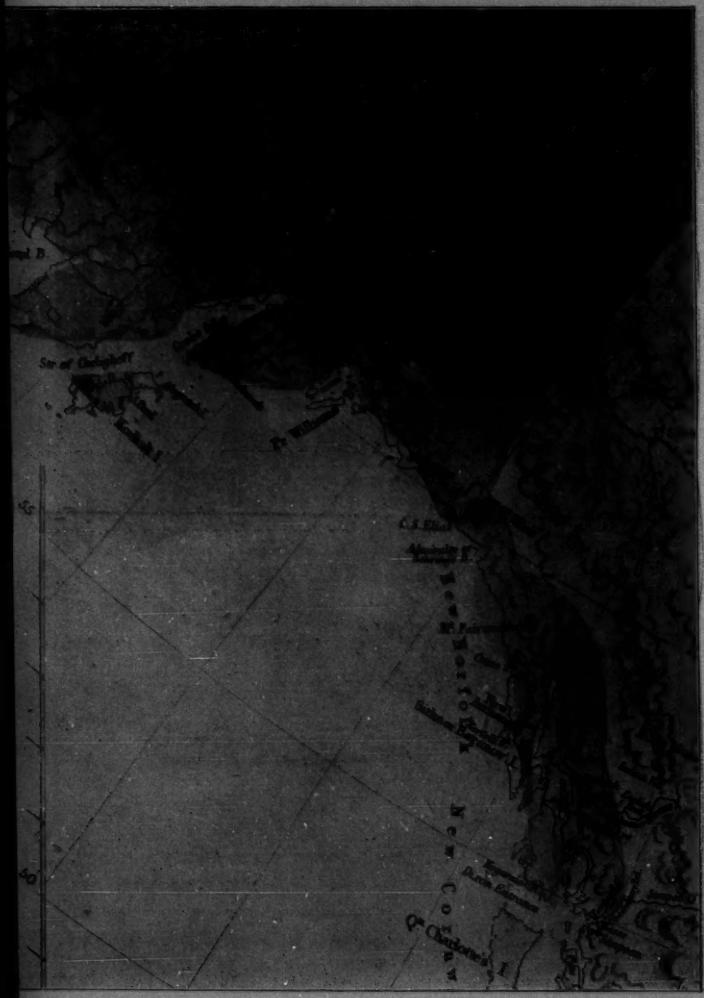

PLATE VII.—Map of the Hudson's Bay Company: "Ordered by the House of Commons to be printed 31st July and 11th August, 1857." The Russian territory, which is darker than the Canadian in this reproduction, is colored yellow on the original map.

territory altogether from any outlet upon salt water above 54° 40′.

Again in 1867, about the time of the sale by Russia to the United States of Russian-America—to which William H. Seward gave the name of Alaska[16]—"Black's General Atlas of the World" was published at Edinburgh. In the introduction of this work, the following description of Russian-America is given:

"Russian America comprehends the N. W. portion of the continent, with the adjacent islands, extending from Behring Strait E. to the meridian of Mount St. Elias (about 141° W.), and from that mountain southward along the Maritime chain of hills till it touches the coast about 54° 40′."

Then, on three maps of this atlas, "The World," No. 2, "The World on Mercator's Projection," No. 3, and "North America," No. 39, the Russian territory from Mount Saint Elias down to the end of the Portland Canal at 54° 40′ is marked so as to include within the Muscovite possessions all the fiords and estuaries along the coast and thus cutting off the British territory entirely from all access to tide water above 54° 40′. In addition there is given a small map marked at the top, "Supplementary sketch map, Black's General Atlas, for Plate 41," and at the bottom, "United States after Cession of Russian-America, April 1867, Coloured Blue." On this sketch map the territory purchased by the United States is marked, "Formerly Russian America," and like the rest of the United States it is colored blue. And the boundary of the new territory of Alaska is given as upon the other three maps of this atlas, Nos. 2, 3 and 39, already cited, according to Brué's map of 1825, and Krusenstern's map of 1827, and the Canadian and the English maps already referred to, and in accordance with the territorial claim that Russia and the United States have always maintained and acted upon.

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[16] "Seward at Washington as Senator and Secretary of State," by Frederick W. Seward. New York: 1891, Vol. III, p. 369.

Concerning the sale of Alaska by Russia to the United States, see "Speech of Hon. Charles Sumner, of Massachusetts, on the cession of Russian-America to the United States;" 1867, *passim*, and "The Alabama Arbitration," by Thomas Willing Balch, Philadelphia, 1900, pp. 24–38.

Many other maps can be mentioned, in addition to those above quoted, against Britain's recent claim. For examples, Petermann's map in the *Mittheilungen*, of April, 1869; Thomas Devine's map prepared and printed in 1877 at Toronto by order of the Canadian Government; Alexander Keith Johnston's map of "North America" in his "Handy Royal Atlas of Modern Geography," published at Edinburgh and London, in 1881; E. Andriveau-Goujon's map of "l'Amérique du Nord," published at Paris in 1887; and finally the wall map (1897) of the "United States" by Edward Stanford,[17] an important map-maker of London to-day, give to Alaska the limits always claimed since 1825 by Russia and the United States.

Some maps—for example, "The World," by James Gardner, published in 1825 and dedicated "To His Most Gracious Majesty George the IVth;" "Nord America, Entworfen und gezeichnet von C. F. Weiland," 1826; and a "carte Physique et Politique par A. H. Brué," 1827—bring the Russian boundary on the mainland from Mount Saint Elias down only to a point about half way opposite Prince of Wales Island at about 56°, and then along the estuaries so as to include all of Prince of Wales Island in the Russian Territory, instead of carrying the frontier to the top of the Portland Canal and then down to the sea at about 54° 40′ But for all the territory above the point on the continent about half way opposite Prince of Wales Island up to the 141° west from Greenwich, these maps give the divisional line between the Muscovite and the British territories, far enough inland and around the sinuosities of the coast so as to cut off the British territory from all contact with tide water. Besides, Weiland, in a map of 1843, corrected his error in his map of 1826 in stopping a little short of the Portland Canal in marking the Russo-Canadian boundary; and in Brué's maps of 1833 and 1839 the divisional line is given as it was marked on his map of 1825. Gardner's map is overwhelmed by the multitude of English and Canadian maps—governmental and private—that followed Krusen-

[17] "The United States." London: Published by Edward Stanford, 26 and 27 Cockspur Street, Charing Cross, S. W., July 15, 1897.

stern's delineation of the line of demarcation. And additional proof of how far south the negotiators of the treaty of 1825 intended that the Russian *lisière* should extend when they used the phrase, "la dite ligne remontera au nord le long de la passe dite Portland Channel, jusqu'au point de la terre ferme ou elle atteint le 56e degré de latitude nord," is clearly shown by Vancouver's chart, upon which he inscribed the name "Portland Canal."[18]

Probably the most important English map as showing what the best geographers of the British Government thought, until very recently, was the true boundary, is the British "Admiralty Chart No. 787," giving the northwest coast of America from "Cape Corrientes, Mexico to Kadiak Island," prepared in 1876, by F. J. Evans, R. N., published in 1877, and corrected up to April, 1898. On this chart of the British Admiralty, the frontier of the United States descends the 141° of longitude west from Greenwich, and then advancing on the continent, but passing round the sinuosities of the coast so as to give a continuous *lisière* of territory cutting off the Dominion of Canada from all contact with any of the fiords or sinuosities that bulge into the continent between Mount Saint Elias and the Portland Canal, the frontier is drawn to the head of the Portland Canal in about 56°, and then down that sinuosity, striking Dixon's entrance at 54° 40′. *Thus the British Admiralty itself upholds the territorial claims held and maintained by both the Russian and the United States Governments.*[19] (Plate VIII.)

The English and the Canadian Governments, through their official representatives, have again and again recognized the claim of Russia down to 1867, and since then that of the United States, that the area of Russian-America or Alaska comprises an unbroken strip of territory on the con-

[18] "A Chart shewing part of the Coast of N. W. America with the tracks of His Majesty's Sloop Discovery and Armed Tender Chatham commanded by George Vancouver."

[19] I bought the copy of this chart, from which map Plate VIII is reproduced, at Edward Stanford's, 26 and 27 Cockspur Street, Charing Cross, S. W., London, in September, 1901, showing that up to that date, at least, the British Admiralty agreed with the United States as to the frontier.

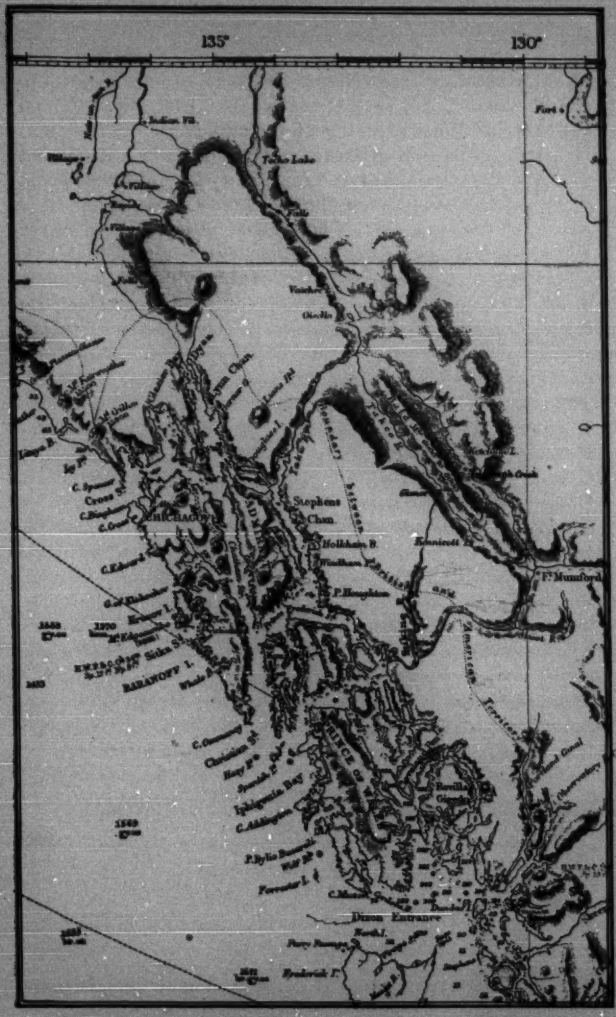

PLATE VIII.—British Admiralty Chart, published June 21, 1877, under the superintendence of Captain F. J. Evans, R. N. Hydrographer, and corrected to April, 1898.

tinent, extending from Mount Saint Elias in the north to the Portland Canal in the south; that this strip of land encircles all the sinuosities of the shore; and that by this strip the Dominion of Canada is cut off from all contact with the indentations of the sea along the northwest coast of the continent between the Portland Canal at about 54° 40′ north latitude and Mount Saint Elias. From these numerous official acts, a few are presented here.

In 1857 a "Select Committee" of the House of Commons of the British Parliament was appointed "to consider the state of those British Possessions in North America which are under the Administration of the Hudson's Bay Company, or over which they possess a License to Trade."[20] The committee consisted of nineteen members in all, among whom were Mr. Secretary Labouchere, chairman; Lord John Russell, Lord Stanley, Mr. Edward Ellice, a native of Canada and a director of the Hudson's Bay Company, Mr. Gladstone, Mr. Roebuck, and Sir John Pakington. The committee examined, among others, Sir George Simpson, who for thirty-seven years was the governor of the territories of the Hudson's Bay Company. Part of Sir George Simpson's testimony was as follows:

"1026. Besides your own territory, I think you administer a portion of the territory which belongs to Russia under some arrangement with the Russian Company?—There is a margin of coast marked yellow in the map from 54° 40′ up to Cross Sound, which we have rented from the Russian-American Company for a term of years.

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[20] Parliamentary Papers, 1857

Accounts a — Rep. XV.

Report from the Select Committee on the Hudson's Bay Company together with the proceedings of the Committee, minutes of evidence, Appendix and Index. Ordered, by the House of Commons, to be printed 31 July and 11 August, 1857.

Second Session, 1857.

Veneris, 8° die mail, 1857.

Ordered, That a Select Committee be appointed "to consider the state of those British Possessions in North America which are under the Administration of the Hudson's Bay Company, or over which they possess a License to Trade," (page II.).

"1027. Is that the whole of that strip?—The strip goes to Mount Saint Elias.

"1028. Where does it begin?—Near Fort Simpson, in latitude 54°; it runs up to Mount Saint Elias, which is farther north.

"1029. Is it the whole of that strip which is included between the British territory and the sea?—We have only rented the part between Fort Simpson and Cross Sound.

"1030. What is the date of that arrangement?—That arrangement, I think, was entered into about 1839.

"1031. What are the terms upon which it was made; do you pay a rent for that land?—The British territory runs along inland from the coast about 30 miles; the Russian territory runs along the coast; we have the right of navigation through the rivers to hunt the interior country. A misunderstanding existed upon that point in the first instance; we were about to establish a post upon one of the rivers, which led to very serious difficulties between the Russian-American Company and ourselves; we had a long correspondence, and to guard against the recurrence of these difficulties it was agreed that we should lease this margin of coast, and pay them a rent; the rent, in the first instance, in otters; I think we gave 2,000 otters a year; it is now converted into money; we give, I think, 1,500£ a year."

It will be observed from the foregoing questions and the replies of Sir George Simpson, that the Hudson's Bay Company in 1839, recognized by an official act, to wit, a lease of Russian territory, that Russia had a *lisière* on the continent from Mount Saint Elias almost down to Fort Simpson, and that owing to this strip of land the British territory was pushed back about thirty miles "inland from the coast." In addition it will be noted that Sir George Simpson in describing the positions and extent of the land rented by his company from the Russian Company, referred to a map that he showed the committee, and upon which the *lisière* belonging to Russia was marked so as to include the sinuosities of the coast, the Lynn Canal and all the others fiords above 54° 40′, *entirely*, and so cutting off the

English territory absolutely from all contact with tide water.

Subsequently, in the course of Sir George Simpson's examination, the question of the lease in 1839 by the Hudson's Bay Company of the Russian *lisière* again came up, and the following questions and answers were asked and given:

"1732. Chairman. I think you made an arrangement with the Russian Company by which you hold under a lease a portion of their territory?—Yes.

"1733. I believe that arrangement is that you hold that strip of country which intervenes between your territory and the sea, and that you give them 1500£ a year for it?—Yes.

"1734. What were your objects in making that arrangement?—To prevent difficulties existing between the Russians and ourselves; as a peace offering.

"1735. What was the nature of those difficulties?—We were desirous of passing through their territory, which is inland from the coast about 30 miles. There is a margin of 30 miles of coast belonging to the Russians. We had the right of navigating the rivers falling into the ocean, and of settling the interior country. Difficulties arose between us in regard to the trade of the country, and to remove all those difficulties we agreed to give them an annual allowance. I think, in the first instance, 2,000 otter skins, and afterwards 1500£ a year.

* * * * * * *

"1738. During the late war [the Crimean] which existed between Russia and England, I believe that some arrangement was made between you and the Russians by which you agreed not to molest one another?—Yes, such an arrangement was made.

"1739. By the two companies?—Yes; and Government confirmed the arrangement.

"1740. You agreed that on neither side should there be any molestation or interference with the trade of the different parties?—Yes.

"1741. And I believe that that was strictly observed during the whole war?—Yes.

"1742. Mr. Bell. Which Government confirmed the arrangement, the Russian or the English, or both?—Both Governments."

This additional information shows that the English Company rented the *lisière* from the Russian Company because the *lisière* shut off the English Company from access to the fiords of the sea that advanced into the continent. And further, these questions and replies prove that the English Government—by confirming the agreement of the English Company with the Russian not to interfere with each other while their respective Governments were busy waging war in other parts of the world during the years 1854, 1855 and 1856—recognized and sanctioned the claim of Russia that she had an unbroken *lisière* on the mainland extending far enough inland so as to envelop within her own domains the Lynn Canal and all the fiords that penetrate into the continent above the Portland Canal.

Some twenty years after the investigation by the House of Commons into the affairs of the Hudson's Bay Company, the Canadian Government, through the intermediary of the British Foreign Office, formally recognized that the *lisière* of Alaska shut off Canadian territory from access to the sea.

It was in 1876, while taking a prisoner named Peter Martin, who was condemned in the Cassiar district of British Columbia for some act committed in Canadian territory, from the place where he was convicted to the place where he was to be imprisoned, that Canadian constables crossed with the prisoner the United States territory lying along the Stickine River. They encamped with Martin at a point some thirteen miles up the river from its mouth. There Martin attempted unsuccessfully to escape, and made an assault on an officer. Upon his arrival at Victoria, the capital of British Columbia, he was tried and convicted for his attempted escape and attack upon the constable, and the court sentenced him. The Secretary of State, Hamilton Fish, protested against this infringement of the territorial sovereignty of the United States in the Territory of Alaska. In a letter to Sir Edward Thornton, the English

Minister at Washington, he said: "I have the honor, therefore, to ask again you attention to the subject and to remark that if, as appears admittedly to be the fact, the colonial officers in transporting Martin from the place at which he was convicted to his place of imprisonment, *via* the Stickine River, did conduct him within and through what is the unquestioned territory of the United States, a violation of the sovereignty of the United States has been committed, and the recapture and removal of the prisoner from the jurisdiction of the United States to British soil is an illegal act, violent and forcible act, which cannot justify the subsequent proceedings whereby he has been, is or may be restricted of his liberty."

The transit of the constables with their prisoner, Martin, through American territory was not due to a mistake on their part as to the extent of Canadian territory, for J. B. Lovell, a Canadian Justice of the Peace in the Cassiar district of British Columbia, wrote to Captain Jocelyn in command at Fort Wrangel, saying: "The absence of any jail here (Glenora, Cassiar), or secure place of imprisonment, necessitates sending him through as soon as possible, and I hope you will excuse the liberty we take in forwarding him through United States territory without special permission." After an investigation into the facts of the case, the Dominion Government acknowledged the justness of Secretary Fish's protest by "setting Peter Martin at liberty without further delay," and thus recognized that the Canadian constables who had Martin in their charge when they encamped on the Stickine thirteen miles up from the mouth of the river, were on United States soil, and so that Canada's jurisdiction in that region did not extend to tide water.[21]

Another recognition by the British Empire that the *lisière* restricted Canadian sovereignty from contact with the sea, occurred shortly after the case of Peter Martin.

Owing to a clash between the United States and the

[21] "Papers relating to the Foreign Relations of the United States." Washington: Government Printing Office, 1877, pp. 266, 267, 271.

Canadian customs officials as to the extent of their respective jurisdiction on the Stickine River, their two governments agreed in 1878 upon a provisional boundary line across that river. The Canadian Government had sent in March, 1877, one of its engineer officers, Joseph Hunter, "to execute," in the language of Sir Edward Thornton to Secretary Evarts, "a survey of a portion of the Stickine River, for the purpose of defining the boundary line where it crosses that river between the Dominion of Canada and the Territory of Alaska." This Canadian engineer, Hunter, after measuring from Rothsay Point, at the mouth of the Stickine River, a distance ten marine leagues inland, determined—in the light of Articles III. and IV. of the Anglo-Russian Treaty of February 16–28, 1825, which two articles he was instructed expressly "by direction of the minister of the interior" to consider in locating the boundary—that the frontier crossed the Stickine at a point about twenty-five miles up the river and almost twenty miles in a straight line from the coast. Without considering whether, owing to the break in the water-shed caused by the passage of the Stickine through the mountains, the United States territory extends inland to the full extent of thirty miles, Hunter decided that the line should cross the river at a point twenty miles back from the coast, but still far enough back from the mouth of the river to shut off Canadian territory from contact in that district with the sea. He came to this decision, because he found that at that point a range of mountains parallel to the coast crossed the Stickine River, and, as he stated expressly in his report to his chief, he acted upon the theory that this mountain range followed the shore line within the meaning of the treaty of 1825 as he understood it. In his report to his government he said: "Having identified Rothsay Point on the coast at the delta of the Stickine River, a monument was erected thereon, from which the survey of the river was commenced, and from which *was* estimated the ten marine leagues referred to in the convention." The Canadian Government sent a copy of this report, together with a map explaining it, through the British Foreign Office to Sir

Edward Thornton at Washington, who communicated it to Secretary William M. Evarts, with the purpose of obtaining his acceptance of this boundary. Mr. Evarts agreed to accept it as a provisional line, but with the reservation that it should not in any way prejudice the rights of the two governments whenever a joint survey was made to determine the frontier. By this voluntary proposal of a provisional boundary across the Stickine River, the British and the Canadian Governments showed that in 1877 and 1878 they considered that Canadian territory above the point of 54° 40′ was restricted by the meaning of Articles III and IV of the Anglo-Muscovite Treaty of 1825 from access to the sea.[22]

The foregoing review of the negotiations that resulted in the treaty of 1825, and the subsequent acts of the nations concerned in the Alasko-Canadian frontier, show clearly that, from the very inception of the negotiations, Russia insisted upon the absolute possession of a continuous, unbroken *lisière* on the continent down to the Portland Channel for the openly expressed purpose of shutting out England from access to the sea above 54° 40′; and that England finally yielded the point.

During Polk's administration (1845–49), when the United States and Great Britain advanced conflicting claims to the territory lying between the Rocky Mountains and the Pacific Ocean, now known as British Columbia, and the supporters of Polk took up the cry of "Fifty-four forty or fight," Russia offered her American possessions to the United States if they would maintain their claim to the territory west of the Rockies up to 54° 40′, the most southern point of Russian-America, thereby shutting out Britain entirely from access to the Pacific Ocean.[23] But owing to the jealousy of the slave power, our government yielded all the country west of the Rockies and above the 49° of north latitude, and

[22] "Papers relating to the Foreign Relations of the United States." Washington: Government Printing Office, 1878, p. 339.

[23] "Papers relating to Foreign Affairs, accompanying the annual message of the President to the second session of the Fortieth Congress," 1867, Part I., Washington: Government Printing Office, 1868, p. 390.

thus permitted the British Empire to obtain an outlet on the Pacific. Not content with this successful territorial extension, the British Empire, after having allowed without a protest for almost three-quarters of a century, the inclusion by the Muscovite and the United States Government within their sovereignty—as is shown both by the maps and other official acts of these two nations—of all the sinuosities or fiords along the coast of the mainland above 54° 40′, the British Empire now lays claim, since the discovery of gold in the Klondike, to a large and to us most important part of our Alaskan domain. The American and the British contentions to-day are well expressed by the pithy sentence in which Count Nesselrode over seventy-five years ago contrasted the efforts of Russia and England when they were seeking to agree upon a frontier between their American possessions: "Ainsi nous voulons conserver, et les Compagnies Angloises veulent acquerir." (Thus we wish to retain, and the English Companies wish to acquire.)

Canada wishes, and she has the support of England, to have her claim—that she is entitled to many outlets upon tide water above 54° 40′—submitted to the arbitration of third parties.[24] The United States should never consent to any such arrangement. If such a plan were adopted, and a decision were given altogether against Canada, she would be no worse off than she has been from 1825 to the present day, while anything decided in her favor would be a clear gain to her. This country, on the contrary, cannot by any

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[24] A letter by the writer, entitled, "Canada and Alaska," briefly touching on the boundary question, was printed in the New York *Nation*, January 2d, 1902, and the New York *Evening Post*, January 4th. Another letter, also under the same title, written by a gentleman at Ottawa, appeared in the same papers, January 16th and 18th, respectively. Still another letter under the title of "Facts about the Alaskan Boundary" was published in the *Nation* of January 23d and the *Evening Post* of January 27th. This last communication was written by a gentleman in California, evidently a Canadian. The Hon. William H. Dall, of Washington, D. C., followed with a strong letter, "The Alaskan Boundary," in the *Nation*, January 30th, and the *Evening Post*, February 1st. Then another communication by the writer, "Canada and Alaska," was given a place in the *Nation*, February 6th, and the *Evening Post*, February 7th.

possibility obtain more than she now has, viz., that which she purchased from Russia in 1867, and to all of whose rights she succeeded; at the same time the United States can lose heavily. For the inclusion in Canadian territory of only one port, like Pyramid Harbor or Dyea on the Lynn Canal, would greatly lessen for the United States the present and future value of the Alaskan *lisière*. The evidence in the case is overwhelmingly on the side of the United States and shows that they are entitled, by long, uninterrupted occupancy and other rights, to an unbroken strip of land on the continent from Mount Saint Elias down to the Portland Channel. There is no more reason for the United States to allow their right to the possession of this unbroken Alaskan *lisière* to be referred to the decision of foreign judges, than would be the case if the British Empire advanced a claim to sovereignty over the coast of Georgia or the port of Baltimore and proposed that this demand should be referred to the judgment of subjects of third Powers. For if the claim of Canada to Alaskan territory is referred to foreigners for settlement, the United States can gain nothing, while they will incur the risk of losing territory over which the right of sovereignty of Russia and then of the United States runs back unchallenged for more than half a century. If France advanced a claim to the Isle of Wight and then asked England to refer her title to the island to the arbitration of foreigners, would Great Britain consent? And for the English Empire to advance a demand to many outlets upon tide water on the northwest coast of America above 54° 40′ and then ask the United States to submit this claim to the arbitration of the citizens of third Powers, is a similar case. Whether the frontier should pass over a certain mountain top or through a given gorge is a proper subject for settlement by a mutual survey. But by no possibility has Canada any right to territory touching tide water above 54° 40′. The United States should never consent to refer such a proposition to arbitration.

THE FRANKLIN INSTITUTE.

Stated Meeting, held Wednesday, December 18, 1901.

THE EVOLUTION OF FIRE-ARMS AND ORDNANCE AND THEIR RELATION TO ADVANCING CIVILIZATION.

By General Joseph Wheeler, U. S. A.

During the ages prior to the invention of printing and the making of books, the world seemed almost to stand still. It is true that great minds have existed in all ages as they do to-day. They were manifested by superb excellence in music, painting, architecture, and in literature, both poetry and prose; but when one mind was so fortunate as to make its impress upon the world, millions of equally great intellects lived and died without adding to the intelligence, happiness and well-being of mankind.

Great Thinkers in all Ages.—Evidence is abundant that inchoate thoughts and marvelous inventions were evolved and partly, if not wholly, developed during every century in the far-back, almost hidden ages of the past, most of them dying with the mind that conceived, and others recorded only so imperfectly that the greatest ideas were soon neglected and forgotten.

Each new thinker commenced at the foot of the ladder, and, though he reached a high eminence, he died and left no better starting point than he enjoyed when he commenced his work of investigation.

It is true that accidental observation puts thoughts in people's minds which we call inventions. Newton saw an apple fall to the ground, and the thought of gravity was impressed upon him. Another saw the lid of a teapot forced up by the confined steam, and the power thus manifested taught him the principle of the steam-engine.

Gunpowder: How Invented.—It is said that gunpowder was first invented in China and India many centuries before the Christian era. In many localities in those countries

the soil is impregnated with nitre. All cooking at that time was by wood fires, and the people lived in tents and huts with earth for their floors. Countless fires made of wood upon ground strongly impregnated with nitre must have existed every day, and when such fires were extinguished, a portion of the wood must have been converted into charcoal, some of which would, of necessity, become mixed with the nitre in the soil. By this means two of the most active ingredients of powder were brought together, and it is very natural that when another fire was kindled on the same spot a flash might follow. This would lead to investigation, and then the manufacture of gunpowder was conceived. Whether this be true or not, we have abundant evidence that the origin of gunpowder and artillery goes far back in the dim ages of the past.

Fire-Arms before Christian Era.—The Hindoo code, compiled long before the Christian era, prohibited the making of war with cannon and guns or any kind of fire-arms. Quintus Curtius informs us that Alexander the Great met with fire weapons in Asia, and Philostratus says Alexander's conquests were arrested by the use of gunpowder.

It is also written that those wise men who lived in cities on the Ganges "overthrew their enemies with tempests and thunderbolts shot from the walls." Julius Africanus mentions shooting powder in the year 275. It was used in the siege of Constantinople in 668; by the Arabs in 690; at Thessalonica, in 904; at the siege of Belgrade, 1073; by the Greeks in naval battles in 1098; by the Arabs against the Iberians in 1147; and at Toulouse, in 1218. It appears to have been generally known throughout civilized Europe as early as 1300, and soon thereafter it made its way into England, where it was manufactured during the reign of Elizabeth, and we learn that a few arms were possessed by the English in 1310, and that they were used at Crecy in 1346.

Guns Used against English, 1327.—Greener says (page 5): "Barbour, in his life of Bruce, informs us that guns were first employed by the English at the battle of Werewater, which was fought in 1327, about forty years after the death of Friar Bacon, and there is no doubt that four guns were

used at the battle of Crecy, fought in 1346, when they were supposed to have been quite unknown to the French, and aided in obtaining the victory for British arms. Froissart gives an excellent representation of a cannon and cannoneers in 1390."

Formidable Weapons in Pre-Historic Age.—We have much evidence to prove that far back in the pre-historic age weapons existed of a most formidable character. That they were effective at a long distance is well established, and that the mastodon, the cave bear, and other powerful animals were killed by them is evidence of their deadly nature.

The boomerang and the throwing stick found in the hands of the Australian savage could hardly be improved upon or even equalled at the present time, and it is doubtful if any material improvement was made in weapons of war during the many centuries from the earliest historic age down to the time when fire-arms became generally used as instruments of warfare.

Long-Bow and Cross-Bow were Destructive.—The long-bow and cross-bow were very formidable and destructive weapons. The battles of Poictiers and Agincourt were won almost entirely by soldiers armed with the bow, its length being about the height of a man, and the greater part of the victorious army at Crecy were armed with the same weapon. Marvelous stories come to us as to their range, but probably 600 yards is the longest authentic flight of an arrow from bows of that character, and 400 yards was regarded as an exhibition of great skill.

The cross-bow is of very ancient origin. It is mentioned in the Bible and by Josephus. Pope Innocent III forbade the use of so cruel and barbarous a weapon as the cross-bow against Christians, but sanctioned its use against infidels. Contrary to the orders of the Pope, King Richard I introduced the cross-bow in England, but its use was discouraged by Henry VII, Elizabeth, James, and Charles I, although in 1572 cross-bowmen were sought to engage in the service of Charles IX. The first guns used by soldiers seem to have been called hand-cannon.

Hand-Cannon and Matchlock.—The "hand-cannon," as first used by the French, Italians, and Netherlanders, consisted of a small bombarde affixed to a straight piece of wood, and fired from the shoulder by means of a match.

The first account of the use of hand-cannon in Germany was in 1381, and at the close of the fifteenth century hand-cannon or small fire-arms were in use throughout Europe as military weapons.

The matchlock was in use in 1460, but the opposition to the use of guns, especially hand-guns, was very determined. Armored knights clamored loudly against the use of fire-arms. Thick armor would generally repel arrows which so often glanced, and knights were seldom killed; but the advent of guns and bullets made the armor of little value as a protection. Gunshot wounds were regarded as certainly mortal, and much opposition to the use of guns was manifested. Small cannon were used at Crecy, their first certain employment on the field of battle.

An old French writer says:

"No use has yet been made in France, in 1547, of that terrible weapon against men. The French used it with good effect against some castles in 1338, but they would blush to employ it against their fellow-creatures. The English, less humane, without doubt outstripped us, and made use of some at the celebrated battle of Crecy, which took place against the troops of King Edward III, of England, who was so spiteful and treacherous that he plagued Philip de Valois and his troops to the last; and the greater part of the terror and confusion was occasioned by the cannon, which the English used for the first time, and had placed upon a knoll near the village of Crecy, and to which the French assign their defeat."

Skill of English Archers.—The skill of the archers of England with the long-bow and the lack of skill with the gun caused many to prefer the bow to the gun as a weapon of warfare.

In the reign of Queen Elizabeth, Sir John Smith, a general of much experience, stated that the bow was the superior of the hand-gun, and although he was taken up sharply

by Mr. W. Barwick, Gent., he stuck to his contention. "I will never doubt to adventure my life," he writes, "or as many lives (if I had them) amongst 8,000 archers complete, well chosen and appointed, and therewithal provided and furnished with a great store of cheaves of arrows, as also a good overplus of bows and bow strings, against 20,000 of the best harquebusiers and musketeers there are in Christendom."

Several competitive trials between the gun and the bow are on record, the results generally showing military advantages to the latter. A reliable match decided at Pacton Green, Cumberland, in August, 1792, resulted in a grand victory for the bow. The distance was 100 yards, the bow placing sixteen arrows out of twenty into the target, and the ordinary musket twelve balls only.

Perceiving such results as these so late as the eighteenth century, it is not surprising that in its earlier days the gun proved an inferior weapon to the bow when in the hands of a good archer.

This bad shooting with the gun and its unpopularity was due to the recoil. A few shots so bruised the soldier's arm that his thought was on his shoulder more than his aim, and in spite of himself he would cringe or wince at the moment of firing, and thus deflect the gun.

There is no record of the muskets used at the trials above quoted, but in all probability the "Brown Bess" would be the one chosen, it being the standard military arm at that period.

Opposition to Improved Methods in Military Service.—What is politely called conservatism, in other words, an adherence to ideas or anything else which is old and established, is not as deeply rooted in the minds of people to-day as it was years ago.

Learned men ridiculed the idea of the practical use of steamboats and railroads, and Fernando Wood was ridiculed off the stump when beaten for re-election to Congress, being charged with voting to appropriate $25,000 of the people's money to be used by a crank who claimed that he could hold communication between Washington and Balti

more by means of wires stretched between the two places. Officers of the army and navy of all countries have been even more conservative than the mass of the people.

Many writers have dwelt upon the fact that among military men there has always seemed to be an intangible something which caused them to oppose improved methods or improved weapons, no matter how superior they may have been shown to be.

Napoleon III says, in his valuable treatise on the "Past and Future of Artillery:"

"Inventions which are before their age remain useless until the stock of general knowledge comes up to the level." The Emperor also speaks of "being enamored of old ways and of presenting for ages practices that are most stupid. * * * And not only does *routine* scrupulously observe, like some sacred deposit, the errors of antiquity, but it actually opposes, might and main, the most legitimate and the most evident improvements."

An English writer says: "On looking now at the specimens of early small arms and artillery preserved in museums and arsenals, it is surprising how little change has been undergone, either by ordnance or musketry, during that long period of comparative inaction. Except in the superior composition of the metal, cannon cast in the reigns of the Georges exhibited little alteration or improvement beyond their condition in the time of Elizabeth. The muskets borne by our soldiers in the Peninsula and at Waterloo differed in no essential particular from those with which their ancestors fought at Blenheim, August 17, 1704, and Ramilies; and the substitution of the percussion cap for a flint-lock took place at a still later period."

Even Napoleon and his Marshals were Unprogressive in Armament.—Nor was this display of apathy confined to England alone. Almost every other nation in Europe concurred in manifesting the same contented indifference. Marmont, to the close of his life, upheld the old musket as the most formidable and effective of all possible weapons; and Napoleon withdrew the rifle from the imperial troops, to whom it had been partially issued during the wars of the Republic;

nor was it restored to the French armies till after the invasion of Algeria, in 1830, when it was adopted for the equipment of the Chasseurs d'Orleans.

The Duke of Wellington was often heard to say that, "looking to the amount of mechanical skill in England, and the numerical weakness of the English army as compared with those of the great Continental Powers, British troops ought to be the best-armed soldiers in Europe."

While duly aware of the imperfections both of small arms and ordnance, the Duke was equally competent to form a correct estimate of the difficulties which beset their removal; but amongst these he did not for a moment admit the force of military *routine*, which, next to rash innovation, Napoleon III has pronounced to be the most redoubtable enemy to all improvement, regarding errors as sacred only because they are old.

The Duke, so far from being a partisan of "Brown Bess," gave his sanction to its supersession by the Minie-rifle in 1851. But before authorizing the adoption of the rifle, he justified the measure in his own mind, not only by the example of the French and Belgian experiments, but by personal inspection of the ease with which the gun could be managed by the man, and the facility afforded by it for loading. It gave place a few years after to the Enfield; and slight as was the superiority which the Minie, when first introduced, presented over the antiquated musket of the previous century, its partial introduction by the Duke of Wellington was the only improvement that up to that time had been made in the construction of small arms.

An English author in reference to the period (about 1830) said: "Prior to that time, however, some perception of the superiority of the rifle had begun to be felt in Great Britain, after its efficiency had been witnessed in the hands of the Americans, whose marksmen had been indebted to its skilful use for their advantages over ourselves, as well as for subsequent successes in their expeditions against the Mexicans."

While the Duke of Wellington was quite inclined to the conservative idea, he was less extreme in his views than many distinguished officers of that period.

Excellent breech-loading rifles were made in England, and in use when he was a child.

Both Wellington and Napoleon were too well informed not to have known that neither breech-loaders nor revolvers are inventions of modern date. Both were known in Germany as early as the close of the sixteenth century. There are in the Musée d'Artillerie at Paris wheel-lock harquebuses of the sixteenth century which are breech-loaders; and there is, in the Tower Armory, a revolver with the old matchlock, the date of which is about 1550. A German harquebus of the sixteenth century, in the museum of Sigmaringen, is a revolver of seven barrels. Nor is rifling a new thing in firearms, for there was a rifled variety of the old harquebus of the sixteenth century, in which the balls were driven home by a mallet, and a patent was taken out in England for rifling in 1635.

Breech-Loaders and Percussion Locks Opposed.—There is now a breech-loading rifle in the War Department library which was invented in 1775 and was used by the British troops at the battle of Brandywine on September 11, 1777, and excellent breech-loaders are now at Fort Monroe which were made by the Chinese possibly a thousand years ago.

The percussion-lock was invented in 1800, and was patented in England in 1807, and yet the man who is held up in England as the superior of Napoleon fought all his wars with the muzzle-loading flint-lock.

Now, all this was bad enough; but in the face of abundant information that breech-loading arms had been before the public throughout the world for centuries, and despite the fact that the percussion-lock was publicly advocated in 1807, and in general use in Europe from 1838, and I might say almost universal use in 1846, and manufactured in our arsenals in 1844 and 1845, 1846 and 1847, our army fought the Mexican War with flint-lock arms, most of them the old musket.

I read very recently the following: "In 1842 percussion-locks were adopted, and when the Mexican War broke out there were enough to have armed the troops, but General Scott preferred the flintlock musket."

I think the writer was in error as to the quantities of guns with percussion-locks in May, 1846, but with energy every soldier of General Scott's army could have been given a gun of that character.

Percussion muskets were manufactured at the Springfield Armory in 1844. The records of the War Department show that during that and the next four years the percussion muskets manufactured by the government were as follows:

1844	2,956
1845	14,332
1846	26,468
1847	26,300
1848	26,017

Infantry in Civil War Armed with Muzzle-Loaders.—But worse than all that, the War of the States came on in 1861, and this great government, with its ports open and unlimited resources, and with inventors of excellent breach-loading arms begging the government to purchase, the old muzzle-loader was kept in use.

These efforts were so persistent that Floyd, a civilian Secretary of War, in his report written during the summer of 1859 in referring to breach-loading arms, said:

"Under the appropriations heretofore made by Congress to encourage experiments in breech-loading arms, very important results have been arrived at. The ingenuity and invention displayed upon the subject are truly surprising, and it is risking little to say that the arm has been nearly, if not entirely, perfected by several of these plans. These arms commend themselves very strongly for their great range and accuracy of fire at long distance; for the rapidity with which they can be fired, and their exemption from injury by exposure to long-continued rains. With the best breech-loading arm, one skilful man would be equal to two, probably three, armed with the ordinary muzzle-loading gun. True policy requires that steps should be taken to introduce these arms gradually into our service, and to this end preparations ought to be made for their manufacture in the public arsenals."—*Report of the Secretary of War, 1859.*

After the War of 1861 began, the government was induced to supply a portion of the cavalry with breech-loaders, and the following is a list of guns of that character purchased and manufactured during the five years ending June 30, 1866, a great number, probably the most of them, being supplied during the last half of the period mentioned, and many even issued after the war had closed. The list is as follows:

1,509 Ballard,	20,002 Maynard,
1,002 Ball,	1,001 Palmer,
55,567 Burnside,	20,000 Remington,
9,342 Cosmopolitan,	80,512 Sharps,
22,728 Gallagher,	30,062 Smith,
1,052 Gibbs,	94,156 Spencer,
3,520 Halls,	25,602 Starr,
11,261 Joslyn,	4,001 Warner,
892 Lindner,	151 Wesson,
14,495 Merrill.	

General Dyer, Chief of Ordinance, in his report for 1864, said: "The use of breech-loading arms in our service has, with few exceptions, been confined to mounted troops."

We see here that the infantry received substantially no breech-loading arms, and it was not until the war was over that the question was "to receive early attention."

Indescribable Opposition to Progress.—Captain Kimball, of the Navy, in an article in *Scribner*, in 1889, in referring to this indescribable something, sarcastically said: "The English bowmen made a gallant stand against the ignominy consequent upon the use of the brutal musket; the French bravely rejected the breech-loader in the Napoleonic wars; the Americans did nobly in refusing to use percussion-lock guns in Mexico, and in greatly preferring wonderfully bad muzzle-loaders to comparatively effective arms with which to kill each other during the Rebellion; but all these heroic attempts at stopping military progress fade into insignificance when one contemplates the glorious resistance to the utilizing of magazine mechanisms upon the rifle."

It would seem difficult to account for these repeated anomalies, but when we reflect that armaments are selected by experienced soldiers, and that they have been indelibly

impressed with the excellence of weapons which they have used, and that they realize that any change would require a new course of instruction, and at the same time involve great expense in the change of armament, some idea is conveyed as to the reasons why they desire to adhere to old systems and weapons.

Even in late years, when a hammerless gun was offered to the government, officers of distinction urged as a serious objection that it would be impossible for the soldier to come to support arms. It seemed not to have occurred to them that the manual of arms could be changed and that there was no necessity for ever holding a gun in such a position.

It is said that when Sir Isaac Newton was sitting at his desk near a fire-place, deeply absorbed in an intricate problem and the fire had become so hot as to really give him pain, he cried to his servant to move the fire away. The servant saw that his master's mind was entirely on his work, and as he could not move the fire-place he asked Sir Isaac if it would not do as well for him to move his chair. Sir Isaac's mind reverted for a moment to things terrestrial and said: "I had not thought of that."

Naval Battles at Manila and Santiago Fought with Black Powder.—Smokeless powder was invented prior to 1886 and was in general use in Europe soon after that date.

It was adopted by us, together with the Krag-Jorgensen, in 1892, and yet in June, 1898, every infantry volunteer regiment went to Cuba as an army of invasion armed with the old Springfield rifle with black powder cartridges. The Spanish had smokeless powder and the Mauser-rifle, which many experienced officers regard as better than the Krag-Jorgensen. Even in the far-off Philippines, the insurgents were armed with the Mauser and Remington.

But what is still stronger evidence of this too conservative spirit, notwithstanding that smokeless powder has been used for heavy guns for ten years, black powder, with its clouds of smoke, was the only kind furnished to Dewey at Manila, or to Sampson, Schley and Clark at Santiago, and the "Brooklyn" was so enveloped in a mountain of smoke

that officers on adjacent ships only knew that the "Brooklyn" had not gone to the bottom by hearing the thunder of her guns as this noble cruiser hurled tons of iron missiles into the Spanish ships.

Militia Laws, Antiquated and Obsolete.—But should we criticise army officers for this adherence to things that are old, when we are confronted with the fact that the Congress of this progressive country has been even more derelict in this respect than its servants, the officers of the army. During my substantially twenty years' service in Congress, I made several attempts to secure legislation which would modernize the laws regarding that great arm of defence, the "militia of the United States," but owing to the inflexible rules which govern the House of Representatives, all such efforts proved to be unavailing, and to-day the law regarding our militia, which was enacted the 8th day of May, 1792, and amended the 2d day of March, 1803, with all its utter inapplicability to present conditions, is nevertheless now the law of the United States.

The following is, *verbatim*, the present law with regard to arming the militia, as it is solemnly reproduced in the latest copy of the revised statutes of the United States (page 285):

"THE MILITIA."

"SEC. 1625. Every able-bodied male citizen of the respective states, resident therein, who is the age of eighteen years, and under the age of forty-five years, shall be enrolled in the militia.

"SEC. 1626. It shall be the duty of every captain or commanding officer of a company to enroll every such citizen residing within the bounds of his company, and all those who may, from time to time, arrive at the age of eighteen years, or who, being of the age of eighteen years and under the age of forty-five years, come to reside within his bounds.

"SEC. 1627. Each captain or commanding officer shall, without delay, notify every such citizen of his enrollment, by a proper non-commissioned officer of his company, who may prove the notice. And any notice or warning to a citizen enrolled, to attend a company, battalion or regimental muster, which is according to the laws of the state in which it is given for that purpose, shall be deemed a legal notice of his enrollment.

"SEC. 1628. Every citizen shall, after notice of his enrollment, be constantly provided with a good musket or firelock of a bore sufficient for balls of the eighteenth part of a pound, a sufficient bayonet and belt, *two spare flints*, and a knapsack, a pouch with a box therein to contain not less than twenty-four cartridges, suited to the bore of his musket or *firelock*, each car-

tridge to contain a proper quatity of powder and ball; or with a good rifle, knapsack, shot-pouch and *powder-horn*, twenty balls suited to the bore of his rifle, *and a quarter of a pound of powder*; and shall appear so armed, accoutered and provided when called out to exercise or into service, except that when called out on company days to exercise only, he may appear without a knapsack. And all arms, ammunition and accouterments so provided and required shall be held exempted from all suits, distresses, executions, or sales for debt or for the payment of taxes. Each commissioned officer shall be armed with a sword or hanger and *spontoon*."

It will thus be seen that every member of the militia or state organizations, and as to that matter, practically all citizens of the United States, who are not exempted by law from militia duty, are violators of the law who have not supplied themselves with a musket or firelock, bayonet and belt, two spare flints, a knapsack, cartridges or a good rifle with shot pouch, powder horn, balls, a quarter of a pound of powder and various other things too numerous to mention, and at this time very difficult, if not impossible to obtain, and absolutely worthless for battle, if unfortunately they were obtainable.

As but few of us have ever heard of a "spontoon," I will explain that it means a pike or a halberd or a long-handled weapon.

American Officers Now Show Progressive and Commendable Spirit.—I am glad to say that American officers of this period are showing a most commendable spirit, and this struggle for improvement is growing stronger every day; but while in many things we lead the world, we have up to this time kept a little behind in weapons of war.

That this condition will no longer exist there is abundant evidence. The "Bureau of Ordnance" and the "Board of Ordnance and Fortifications," both of which are composed of very able and distinguished officers, are giving most intelligent investigation to new inventions, and every possible encouragement to inventors who have anything of real merit to present.

What is true of the army is equally true of the navy. Both services seek to do full justice to inventions by civilians, and this wise and intelligent action on their part will prove of great benefit to the army and navy.

Non-Recoil and Automatic Guns.—For several years inventors have devoted much effort towards contriving methods by which recoils of guns could be lessened, and, if possible, entirely neutralized. The advantage of this would be quite apparent to sportsmen as well as to soldiers.

After several shots with ordinary guns the recoil so bruises the arm that the soldier's mind is largely distracted from his duty by the anticipated shock, and almost unconsciously cringes as he pulls the trigger, thus very materially disturbing the aim.

A gun without any recoil, and which could be fired several times without being taken from the shoulder would, therefore, have an advantage over the old arm which, it is no exaggeration to say, would double the efficiency of the soldier.

The effect of the operation of such a gun would be somewhat like the column of water from a hose-pipe. The eye of the fireman is constantly upon the point he wishes to strike, and by the slight movement of the nozzle he changes the direction until the flow of water is upon the desired point. If the fireman were compelled to look down upon the pipe every other moment, he would be constantly losing his bearing, and would be obliged to regain it every time he looked up, and would be constantly commencing anew.

So with this new fire-arm, the soldier's eye being constantly upon the position of the enemy, and very often by the cutting of twigs, or throwing up dust, he can tell how far he has shot to the right or left, or if too low, and like the fireman with the hose, by the slightest change of his aim, he will be better able to hit in the succeeding shots, while the chance would be much less if the gun was taken from the shoulder and the eye taken off the enemy after each shot.

To Neutralize Recoil of Cannon Very Advantageous.—Also, a device which would neutralize the recoil in cannon would be even a greater advantage than in small arms. Especially would this be true in the navy, where the recoil of heavy guns proves very injurious to a ship. Thus, the injury to

the "Iowa," "Texas" and "Brooklyn" in firing during the Santiago campaign was such that much time and money had to be spent to repair the damage.

The devices heretofore existing to neutralize the recoil of heavy guns have involved the use of weights, many of them as heavy as fifteen tons and some exceeding thirty tons. It will therefore readily be understood that an invention by which the recoil if neutralized by the energy of the expansion of the same gas as is used to throw the projectile should be highly appreciated.

Greener says, page 337: "The recoil of an ordinary 12-bore gun, loaded at the muzzle, varies from 40 to 48 pounds, seldom exceeding the latter; that of a breech-loader varies from 68 to 76."

Experiments with the 45 caliber Springfield rifle showed a free recoil of 19·84 foot-pounds energy for black or ordinary gunpowder, while experiments with smokeless powder give a recoil of 17·06 foot-pounds. In this experiment a 500-grain bullet was used and the muzzle velocity was 1,259 feet per second.

Other experiments have shown that the ratio of recoil energies of black and smokeless powders have been found for general practical purposes as 1·18 to 1.

The recoil of a gun measured in pounds means that the gun in recoiling compresses a spring by the same amount that it would have been compressed if a dead load of the same number of pounds had been placed on the spring in a vertical position.

Captain Dunn, of the Ordnance Department, in discussing this subject, uses these words: "It has been a generally accepted opinion that the further development of power in the rifle must be attended by increased recoil and that the latter was already equal to the average soldier's endurance."

Importance of Skilful Firing.—There is one and but one purpose in engaging in battle, and that is to gain the victory over the enemy.

There is one and only one purpose in placing arms in the hands of the soldiers composing the army, and that is to enable him to shoot, and either kill or disable soldiers

of the opposing army, and the construction and use of fire-arms should all be of a character to best attain that purpose, while at the same time the soldier is as far as possible screened from the enemy's fire.

The tendency of soldiers has been to fire so high that fully 95 per cent. of their charges were ineffective.

During the battles of the Civil War, which occurred in a wooded country, the tops of the highest trees were cut to pieces, and in all engagements at night or even in twilight, it was very plain to see that most of the guns were fired at too great an elevation. This was due in a great measure to the fact that from three to five times as much time was occupied in loading as in firing, and the attention of the soldier was in that way largely diverted from the one essential purpose for which he had been put in action.

All this was true when the main line of the army was engaged, but its importance became much intensified in the case of soldiers firing upon the skirmish line. During the Civil War, on both sides much attention was paid to teaching the skirmish line to never fire until an enemy was visible against whom they could direct a shot.

Now, substantially all battles are fought in open order, and all things being equal, the successful army will be the one whose soldiers are so armed and drilled that their entire attention and thought can be directed upon the one main object of their presence on the field.

This cannot be done with any gun which requires the soldier after firing to take his gun from his shoulder, take his eyes off the enemy, throw out the shell, place a cartridge in position and then return the gun to the shoulder ready for firing. The very fact of his doing all this while under fire tends to create a nervousness which would not exist if his eyes and attention had been constantly upon the enemy.

The tendency in the battles of the present day is to fight at a very long range, and especially is this true when armies are forming and making preparations for an attack. The skirmishers are generally lying down, and with the shelter of grass or a small bush or a log or stone can very generally

be so concealed that it is difficult for the enemy to distinguish them from something inanimate.

Officers who have served on the skirmish line have often found soldiers insisting that certain objects before them were the enemy's skirmishers, when careful observation would show that the object referred to was a log or stump or something of that character.

Again, they have often seen the soldier on the enemy's skirmish line remain so quiet that it took careful observation to discern a movement by which his real character could be determined, and this movement was very generally the movement of the arm necessary to prepare the gun for firing.

Non-Recoil Semi-Automatic Gun is Essential.—It will be easily understood what a great advantage it would be for a soldier to have a gun which could be fired repeatedly without, or substantially without, any movements of the arms or hands, thus enabling him to keep his eyes constantly upon the object against which he was directing his fire.

During campaigns it is often the case that both armies place their advance lines in entrenchments, and each side is constantly watching an opportunity to fire when the opposing soldiers show their heads or shoulders above the breastworks.

In such case it would be a great advantage to have a gun which could be fired with accuracy several times without taking the eye from the enemy and without removing the gun from the shoulder. He would have his eye constantly upon the enemy's parapet, and every exposure above the parapet would enable him to make an effective shot.

Officers have often heard the idea advanced that in order to enable a soldier to fire deliberately it is necessary for him to take his gun from his shoulder after firing, and go through the several motions which are necessary in most modern guns to throw out the shell and place another cartridge in position. I think this is a great mistake. There is now no question but that if a soldier is saved this interruption he can, with proper training, be made to fire with more deadly deliberation and with much more accuracy.

Marksmanship little Considered up to Thirty Years Ago.—Until within the last thirty years very little attention was paid to marksmanship.

Lord Roberts said that when he first entered the army, with the exception of a few scattered skirmishers, opposing lines had to approach to within some eighty yards of each other before they could open fire with any chance of hitting one another. There was then much to be urged in support of the theory that marksmanship was but a small matter in comparison with drill. Lord Roberts also remarked that it frequently happened in our conservative army (the English army) that theory long outlived the conditions which had given it birth, and as lately as twenty years ago there were many commanding officers who looked upon target practice as an unnecessary nuisance forced upon them by the authorities to the detriment of drill, and therefore of service efficiency.

Range of Old Musket and Bad Marksmanship.—The range of the old musket was very uncertain, and many writers of that period contended, that although officially said to be effective at a range of 200 yards, it was the working rule of the soldier to reserve his shot *till he saw the whites of his enemy's eyes*, and even then it was said that before he could bring down his man he must fire a full weight of his body in lead.

Less than forty years ago, a well-trained marksman, provided with an old regulation musket, was placed to fire at a target 18 feet square, from a distance of 300 yards, and found that he could not even put into that spacious area *one bullet out of twenty*. At 200 yards his success was no greater, and yet, the fire-arm thus tested, was the regular weapon of the British soldier, so late as the year 1852.

In 1838, a series of experiments were undertaken by the officers of the Royal Engineers, at Chatham. The target first employed was 3 feet wide and 11 feet 6 inches high, and was struck by about three-fourths of the balls at 150 yards, fired with full charges—with reduced charges only about one-half hit. About this distance the difficulty of hitting was so great that the width of the target had to be

increased to 6 feet; and, at 250 yards, of ten shots fired with full charges, not one hit the target; at 300 yards, shot after shot was fired without one hitting the object aimed at or its whereabouts being ascertained.

The amount of ammunition fired from large guns without effect has been very great.

In siege operations and in naval warfare the ammunition wasted is far in excess of the injury done to the enemy; so much so, that after the fall of Sebastopol, the surface of the plateau in the vicinity of the captured citadel was strewn with balls as though with the products of a mine of ready-wrought iron.

An officer who saw this, wrote: "I hardly exaggerate in saying that over some dozen acres a smart fellow might have crossed every yard of ground upon iron without laying a foot on the earth. The cannon balls were *thick* in some places, and scattered in others, but the coup d'oeil was indescribable."

Americans the Best Marksmen.—On the other hand, the accuracy of fire by American riflemen has often attracted attention, instances being given in which ten consecutive shots at 220 yards were planted within a space no larger than a small playing card—a feat which up to that period was considered unequaled.

It is, I think, generally admitted that the victory of Jackson, at New Orleans, was largely due to the accurate fire of what were called "backwoods riflemen." Jackson's entire army, including himself, were contemptuously alluded to by the British as men of that character as distinguished from trained soldiers. In fact, Packenham himself, while dying, expressed chagrin that he should lose his life in battle with men so different from the trained soldiers he commanded. The same soldiers that fought in New Orleans, on January 8, 1815, fought under Wellington five months and ten days later at Waterloo. In that battle the French and English armies were at first nearly 1,200 yards apart, but as musketry, as well as grape shot, were at that time unavailing at such a range, the army under Napoleon approached within 200 or 300 yards of the English lines

without suffering serious loss. In battles fought before that time, it was the practice of opposing forces to array themselves at distances varying from 500 to 1,000 and sometimes 1,500 yards.

"Brown Bess," the British gun from 1734 to 1839, weighed 11½ pounds and was 75 caliber. It was then changed to percussion lock, but was not much improved, as a report of British Engineers in 1846 uses these words:

"It appears from their experiments that as a general rule musketry fire should never be opened beyond 150 yards, and certainly not beyond 200 yards; at this distance half the number of shots missed the target, 11 x 6 feet.

This is all changed by the long range and accuracy of fire at the present time.

At the battle of Las Guasunas the American line was formed about 750 yards from the Spanish entrenchment. This approximation was made necessary on account of the formation of the ground. For the same reason the American line was formed at San Juan from 500 to 700 yards from the enemy's entrenchments, which were on the San Juan bridge, at which place the Spaniards were well entrenched. It may generally be assumed that where the country is fairly open and bare of trees lines will be formed a little beyond the range of fire-arms.

The Gun of the Future.—The future gun will be automatic or semi-automatic, worked by the force generated by the expansion of the same gas which causes the flight of the projectile, and the same gas will apply and exercise a force pushing the gun forward just sufficient to neutralize the recoil. Such a gun, beside possessing the advantages before mentioned, can be made very light, and that means much, especially for artillery.

A gun embodying this important feature has been devised by Mr. Samuel N. McClean, and signalizes an advance in arms more important and of greater value than anything which has been invented for a third of a century.

The old rifle, as is well known, was made very heavy in order to lessen the recoil, and for the same reason much metal was put in cannon that with the McClean invention, can be eliminated.

A navy 12-inch gun weighs about fifty-three tons, and its carriage about twenty-seven tons.

An army 12-inch disappearing carriage weighs about 500,000 pounds, the counterweights weighing 150,000 pounds.

If the McClean system could be applied to attain the purpose that is now effected by the disappearing carriage an immense amount of ponderous weights could be eliminated.

PROGRESS OF IMPROVEMENTS IN WEAPONS.

Weapons of warfare and for the chase have been of two distinct types.

First: swords, javelins and battle-axes to be held in the hand; and

Second, weapons by or with which missiles are hurled or projected.

The various stages in the latter type of weapons may be stated as follows:

(1) The primitive use of stones and sticks thrown by the hand as a means of attack or defense.

(2) The sling by which stones were hurled with accuracy for long distances.

(3) The spear thrown with skill and force.

(4) The long-bow.

(5) The cross-bow, the principle of which was applied to large guns called artillery as well as to weapons held in the hand. During the ages when these various improvements were being made, certain deviations from those most commonly used, such as the boomerang, were very skilfully made and used by the people of savage nations, and, in some localities, especially in Assyria, India and China, inventions were developed far in advance of the period when they became generally known to the world.

(6) The most important change was early in the fourteenth century, viz.: The use of elastic gases to drive a projectile from a long tube which was called a gun, the elastic gases being created by the explosion of gunpowder. At first the guns were fired by igniting the powder with a torch held in the hand.

(7) The matchlock.
(8) The wheel-lock.
(9) The more modern flint-lock.
(10) The percussion lock.
(11) The rifle-bore.
(12) The breech-loader.
(13) The magazine gun.
(14) The percussion tape.
(15) The hammerless gun and firing-pin.
(16) The use of a contrivance by which, with a movement of the hand after each shot, the empty shell was thrown out and the new cartridge placed in position. Each of the above were deemed to be marked advances upon preceding methods.

(17) The McClean invention, by the use of which, after the elastic gas has performed its work in driving the projectile, a portion is captured and used to convert the ordinary rifle or field-gun or siege-piece into a machine gun, in which a section of the barrel is made to perform the function of the steam-chest of the steam-engine, and the bullet is made to become both the valve and the cut-off, and the explosive force of the gas is made to press the gun forward the moment the projectile leaves the muzzle, just sufficient to counteract the recoil, while at the same time it operates a wonderfully simple mechanism, throws out the empty shell, instantly reloads the piece, and if desired, repeats the operation in an inconceivably short time until the magazine of the piece is emptied.

The McClean mechanism and inventions apply with equal utility to all classes of fire-arms and ordnance from the smallest pistol, military rifle and sporting arm, to field-guns, siege-guns and to naval guns of largest caliber.

In speaking of the McClean inventions, an eminent military engineer, of almost fifty years' devotion to his profession, said:

"The work of resisting the recoil and reloading the piece, especially in the case of small arms, becomes a serious tax upon the strength of the 'man behind the gun,' and its performance by the surplus energy of the gas is a

most important aid, whether employed by soldier or sportsman. The effect of all this upon the general accuracy of fire can hardly fail to be beneficial. The use of this device in artillery would tend to reduce the weight necessary for carriages, and thus add greatly to the facility and rapidity of transportation upon the field."

When we consider the simplicity of mechanism, the great durability of the parts and the few parts involved, I do not think it is going too far to say that the McClean inventions mark an advance in fire-arms more useful and valuable than anything that has ever preceded them.

In all engagements in which I have ever been a participant, the armament of the soldiers associated with me, unfortunately, has been inferior to that of the opposing forces.

In Cuba and in the Philippines our troops came nearest to enjoying an equality in that respect. There we had the Krag-Jorgensen and the Springfield rifles. We were opposed in Cuba by the Mauser-rifle, and while there is a difference of opinion among officers, I am inclined to regard the Mauser as possessing certain special advantages.

In the Philippines, most of the insurgent fighting force were also armed with the Mauser, though many were armed with the Remington and a few with inferior guns of various description.

These experiences very forcibly impressed me with the paramount importance of our government, by the most searching and thorough investigations and experiments, seeing to it that beyond question of doubt our superb soldiers be furnished with the best possible weapons. This was the main incentive which caused me to become interested in the McClean inventions. My study of this subject convinces me that warfare in the future will be conducted upon scientific principles. It will become an exact science, and we must have scientifically constructed weapons.

Naval Marksmanship.—A great deal has been said in commending the action of our naval officials in what is called lavish expenditure of money for target practice on our naval ships, and the victories at Manila and Santiago

were attributed in a great measure to the vastly superior skill in marksmanship of our cannoneers over those of the Spanish navy.

While this is all true, the facts regarding our marksmanship on those occasions show that with improved guns much better results could be obtained. The report of Admiral O'Neil, Chief of the Bureau of Ordnance of the Navy, dated October 1, 1901 (page 35) says:

"If the lessons of the naval battle of Santiago de Cuba, the 'Bellisle' experiment off the Isle of Wight, the 'Scorpion' experiment at Bermuda, and the recent record of target practice of the North Atlantic fleet teach anything, it is that very few hits are made with large caliber guns, even under the most favorable conditions. At Santiago de Cuba, out of eighty-six shots fired from 12- and 13-inch guns, at distances not exceeding 3,500 yards, but three hits were recorded. In the 'Bellisle' experiments but five hits out of fifteen shots fired from 12-inch guns were recorded, the distance being from 1,300 to 1,700 yards.

"In the North Atlantic squadron, out of twenty-six 13-inch shots fired, none hit the target, which was of large dimensions, the distances being from 2,000 to 4,000 yards.

"At the battle of Santiago de Cuba, 319 8-inch projectiles were fired by the United States vessels, the number of guns engaged being presumably eighteen, the number of hits recorded being thirteen, or less than one per gun, the average number of shots per gun being eighteen."

A more detailed statement regarding the ammunition expended and hits in these naval actions is in the record of the Navy Department, and was kindly furnished me by Admiral O'Neil.

His letter is as follows:

"December 12, 1901.

"*My dear General Wheeler:*

"I enclose memorandum of ammunition expended by the United States vessels at Santiago de Cuba and at Manila, with memorandum showing the number of hits recorded by a board which examined the wrecks of the Spanish ships after the action at Santiago.

"As the vessels were sunk at Manila, no record of hits could be made at that place. Yours truly,

"CHARLES O'NEIL."

HITS AT SANTIAGO.

Oquendo:		
1 12 or 13-inch.		
5 8-inch.		
11 4, 5 or 6-inch.		61
44 6-pounders.		
Viscaya:		
5 8-inch.		
10 4, 5 or 6-inch.		28
13 6-pounders.		
Maria Teresa:		
2 12 or 13-inch.		
3 8-inch.		
5 4, 5 or 6-inch.		29
17 6-pounders.		
2 1-pounders.		
Colon:		
3 4, 5 or 6-inch.		6
3 6-pounders.		
Total		124

AMMUNITION EXPENDED IN THE NAVAL ACTIONS OFF SANTIAGO AND MANILA.

Santiago.	13-inch.	12-inch.	8-inch.	6-inch.	5-inch.	4-inch.	6-pdr.	3-pdr.	1-pdr.
								47 mm.	37 mm.
Indiana	13		61	33			1,744		25
Oregon	34		123	41			1,561		141
Texas		8		97			400		330
Brooklyn			100		473		1,200		200
Iowa		31	35			251	1,056		100
Gloucester							589	780	
Vixen							27		18
	47	39	319	171	473	251	6,580	780	814

Manila.									
Olympia			36		281		1,000		360
Concord				182			220	120	60
Petrel				116				313	
Raleigh				53	341			137	100
Boston			48	162			220	256	420
Baltimore			73	122			547		692
			157	635	622		1,978	826	1,632

At Santiago, 1,300 large caliber and 8,174 small caliber, in all 9,474 shots, out of which 124 hits were recorded, less than one hit out of seventy-six shots. This result was applauded by naval officers as well as the people at large, both in Europe and America. Now, if one hit out of seventy-six shots is applauded as good marksmanship, one can conceive of the fearful waste of ammunition which has heretofore been tolerated.

About One Out of 2,000 Shots Effective with Recoil Gun.—To persons who criticise this ratio as bad marksmanship, I would recall that military writers have asserted that since the use of fire-arms in battle it has taken, upon an average, enough metal in the form of shot to equal the weight of a man to secure one effective shot. This would mean about one effective shot out of 2,000.

Such criminal waste of ammunition seems almost incredible, and this very unbusinesslike condition is due largely to the kind of gun which has been used. The recoil has had much to do with the inaccuracy; and the necessity for taking the gun from the shoulder, the eye off the object, and the mind off the purpose, is responsible for much of the balance.

In the future, war must be conducted upon business principles. The use of a non-recoil, semi-automatic rifle, and thorough drill and instruction of the soldier, will entirely change this very unsatisfactory condition. The effort should be to so train an army that the missing of a shot would be the exception and not the rule, as it has been with the old recoil gun. We may not reach such a perfect degree of excellence, but we can and certainly will approach it.

I have seen the McClean one-pounder cannon fired fifteen times into a bank without re-aiming, and every shot went into the same hole. It was mounted upon light wheels without lock, rested loosely on the trunions, and there was not a particle of recoil. It was this which secured such accuracy.

Science and Skill to Win Future Victories.—Science and scientific skill now enter into every civil vocation. What has heretofore been accomplished by the exercise of manual

strength is now done with a thousand or more times the ease with which it was formerly done by human effort. To-day, one man by the control of steam or electric power does work which a few years ago required the combined strength and exertion of a thousand or more human beings.

The nations which will win victories in the future will be those who use the most skill in the application of scientific methods and scientifically made arms, ordnance and other machines of war.

The lessons taught by the campaigns of Alexander, Hannibal, Cæsar and Napoleon will not be discarded or minimized, but the victorious generals of the future will still study and adhere to the essence of the principles taught by the great commanders of all ages, intelligently applying them to modern conditions, modern methods, modern weapons and modern science.

Celerity of movement, and strategy and tactics, by which the plan of campaign and plan of battle will be nearly accomplished before the enemy can discern the real purpose of the assailing enemy; the concentration of force at the point of battle, the protection of flanks and lines of communication, and assailing those of the enemy, and much else that was important to victory in the past, will be equally important in the future.

In the days of Greece and Rome much was attained by individual strength and individual prowess, and throwing masses upon the enemy; and it was much the same in the knighthood days of the Middle Ages; and Napoleon owed many a victory to his skilful concentration of masses of soldiery. Now it will be concentration and accuracy of fire. The training and drill of the soldier will be carried to a high standard of perfection, and he will be taught that every shot must be well directed and count for a purpose. With such soldiers, armed with the best guns and with skilful generals, victory will be certain.

The A, B and C of warfare is to know all about your own army, all about that of the enemy, and all about the country, and also to know when it is best to use cavalry, when best to use artillery, and when best to rely upon infantry, and

when to use two or even three of these arms at the same time.

Government Should Give Soldier the Best Arms.—Every government should seek to provide those whom they send forward to battle with the best possible weapons for defense or for attack. To fail in this is a crime of the first magnitude. Especially is it a crime in a country like ours, where the best blood of the land always hastens to the country's standard when its prestige, safety or honor is imperiled. All good citizens desire peace with all the world; but there is no truer saying than that to preserve peace is to be always prepared for war.

We do not need and should not have a large army, but the army and navy we have should be the best armed and equipped and instructed of any on earth.

Every invention of war weapons should be thoroughly tested by skilful officers, and Congress should appropriate liberally for this purpose, and we should see to it that no nation has an armament in any respect superior to our own.

ELECTROLYTIC SEPARATION OF TIN.

A curious parallelism is presented between the well-known Hoepfner process for the extraction of copper from its ores and compounds, and a method just patented to Paul Bergsoe, of Copenhagen, for the electrolytic recovery of tin from scrap and waste alloys. The Hoepfner process, it will be recalled, depends upon the varying valence of copper, and consists in bringing a salt of copper in its higher state of oxidation into contact with the ore, whereupon copper passes into solution and the solvent is reduced from the cupric to the cuprous condition; this solution is then electrolyzed with insoluble anodes to deposit one-half of its metal, restoring the remainder to its original valence and reconstituting the solvent. Bergsoe reacts upon tin-bearing materials with stannic chloride, and subjects the stannous salts formed to electrolytic treatment as above, restoring its valence and solvent power, and recovering an amount of metal equivalent to that dissolved. Both methods are simple, and indeed identical in theory. The Hoepfner process has encountered in practice the very serious obstacle of a low-reaction velocity—a solvent action so slow as to render its application to the most commonly occurring ores of copper, the sulphides, of doubtful practicability. From this defect the new process is free, for the stannic salts are energetic solvents. The successful treatment of tin scrap, however, has proven in the past a difficult problem, not only on account of its very low tin content, but because of the tendency of the iron to pass with the tin into solution. As applied to this purpose, therefore, the industrial value of the new process is yet to be demonstrated.—*Electrical World.*

Mining and Metallurgical Section.

Stated Meeting, held Wednesday, November 13, 1901.

UPON THE CONSTITUTION OF BINARY ALLOYS.

By John Alexander Mathews, Ph.D.

Continued from vol. cliii, p. 140.

DISCUSSION.

Mr. A. E. Outerbridge, Jr—I have been much interested in Dr. Mathew's paper, and I wish to ask whether the subject of "segregation" in binary alloys, such as silver and copper, has been studied by these new methods of scientific research. I am led to make this inquiry, having noticed a striking difference in the cooling curves shown in the diagrams of two alloys, one only of which segregates; in these diagrams the cooling curve of an alloy of silver and copper and the cooling curve of an alloy of silver and gold are shown in juxtaposition. The silver-copper curve is very pronounced, and terminates sharply at the point where the eutectic alloy separates; the silver-gold alloy, on the other hand, shows a nearly straight line, and no eutectic. It is well known that alloys of silver and copper segregate while alloys of silver and gold are stable.

More than twenty years ago, long before the modern science of micro-metallurgy had been developed, I had occasion to make an investigation of the rather obscure phenomenon known as segregation of the silver-copper alloys used in coinage, and, incidentally, of the alloys of silver and gold, and copper and gold, in which segregation is almost *nil*.

The standard alloy used for the silver coin of the United States is composed of 900 parts of silver and 100 parts of copper, while the standard for the gold coins is 900 parts of gold and 100 parts of copper.* The gold-copper alloy, when

* A trace of silver is permitted in this alloy.

once formed by melting and thorough mixing, remains practically homogeneous, so that when the metal is cast into ingots and rolled into strips, from which the planchets or blanks are stamped out, all of the pieces are found to be of nearly uniform fineness. Not so, however, in the case of the silver-copper alloy. No matter how carefully the metallic mixture may have been prepared, or how thoroughly the molten metal may have been stirred, it will be found that segregation will always occur, even to such an extent that it is impossible to obtain a fair sample for assay by cutting off a little piece from an ingot, as is commonly done with the gold-copper alloy. The silver assay sample is, therefore, dipped out from the molten silver-copper alloy and poured in a fine stream into cold water, thus cooling the metal instantly in the form of small shot or "granules"; in this way segregation in the sample is avoided, but it has never been overcome in the ingot. It is for this reason that the coinage laws permit a much greater limit of "tolerance" or variation from true standard, in the case of silver coins, than in the case of gold coins; nevertheless, I believe it has actually happened that silver dollar coins struck from metal which originally assayed of the proper fineness have been condemned because the variation in fineness due to segregation in the ingot exceeded the limits allowed by law.

The true cause of segregation has never been satisfactorily explained so far as I know. It does not appear to be associated in any way with the specific gravity of the different metals composing an alloy; thus, for example, with silver-copper alloys it has been found that in certain proportions of silver and copper the silver segregates towards the center of the bar, and in other proportions the richer alloy is found near the surface, while still another curious fact has been proven in this connection, namely, that when silver and copper are alloyed in the proportion of about three-fourths silver and one-fourth copper little or no segregation occurs. In the case of silver-gold alloys there is, I believe, very little if any segregation, and it seemed to me that there may be some connection between these phenomena and those revealed by the diagrams on the screen to which I

have referred, showing a pronounced eutectic alloy in the silver-copper metal and the absence of the eutectic in the silver-gold alloy. I therefore have thought that it might be an interesting as well as appropriate question to ask Dr. Mathews whether the light of microscopic investigation, in connection with the study of the cooling of metals from a molten state, has been cast upon this important unsolved problem in metallurgy?

I may say, in conclusion, that some of the observations on alloys of the precious metals noted herein were made by me as long ago as 1873, in the course of a somewhat prolonged investigation of a method of quantitative spectroscopic analysis then recently proposed by Sir Norman Lockyer and the assayer of the Royal Mint, now Sir Roberts-Austen.* The fact that silver-copper alloys segregate was known long before this time, but was regarded as an unsolvable metallurgical riddle or paradox. I am inclined to believe that a careful and thorough investigation of the micro-structure of different portions of an ingot of silver-copper alloy, in which marked segregation has been shown to exist by the ordinary but very accurate methods of humid assay of silver, would be likely to increase our knowledge of the underlying cause of this somewhat mysterious phenomenon known as segregation.

MR. PAUL KREUZPOINTNER:—The very instructive paper read this evening by Professor Mathews raises a good many questions in my mind concerning the results of scientific research of the structure of metals as to the relation of these results to applied, that is, practical metallurgy. However, before asking questions, I beg to express great pleasure and satisfaction with the progress made in the use of the microscope as applied to metallurgy. Any one who knows anything of the struggles, disappointments and criticisms the pioneers of metallography were subject to sixteen and twenty years ago will appreciate the progress made in this line of scientific work during the last ten years, since when

* "Electrical Spectra of Metals." *Proceedings American Philosophical Society*, May, 1874, Vol. XIV, p. 162.

the microscope has become an indispensable instrument in the work of investigating the properties of metals. But while I would be the last one to deduct even an iota from the value of the work done in this line by Sorbey, Martens, Heyn, Osmond and others, I beg to remind you that members of the Mining and Metallurgical Section of the Franklin Institute deserve credit and recognition for the pioneer work done in this country, and your present president, Mr. Garrison, who took up the work of metallography twenty years ago, preparing the soil for those who were to reap the fruit of his planting, knows what difficulties a pioneer in any line of work has to contend with.

As to some of the points raised by the lecturer it would be interesting to know why a metal, for instance steel, when in a physical state where the eutectic is already more or less clearly formed, still appears to possess tolerably fair physical qualities although a low elasticity. If I understand aright the formation of the eutectic means a more or less complete segregation of the surplus of elements over and above that percentage of elements which eventually form the eutectic, and where the elements composing the metal and which are then still in a fluid state will freeze simultaneously. If segregation means a dissociation of elements; and dissociation contributes to the loosening or lessening of the cohesion by which the crystals are held together and which is an essential in contributing to the strength of a metal, then why is it that metals of such a large segregated structure like illustration No. 3 (I believe, K), where the eutectic has formed or is forming, still show a high degree of cohesive force in daily practice? Is there a mastics formed during segregation which acts as a binder, so to speak, or is the strength produced merely by the mechanical interlocking of the crystals? By this I do not mean that such metal is equal in quality to one of normal conditions, that is, a metal of fine structure free from the disturbing influences of segregation as much as is possible. There is a fertile field yet for the scientific investigator of the structure of a metal and the relation of that structure to the maximum usefulness and serviceability of that metal in daily practice

in determining the effects of heat on the structure in an ascending ratio instead of in a descending ratio, as is the case in determining the cooling curve. What I mean by this is, what is the nature of the various structures of a given metal at various points of heat when we heat that metal from the cold state to the point of fusion? To Brinnel we owe much information in that line, but unless I am mistaken, no such systematic, thorough researches have been made of the structures of metals when heated up to the point of fusion as when cooled down from the point of fusion and the corresponding physical quality at these different structures. I am well aware of the many detached and sometimes practically valuable investigations on the lines I refer to, but what the practical metallurgist, the expert, who has neither the time nor facilities to make continuous investigations needs, is a series of illustrations of the microstructure of the most frequently used structural metals at different degrees of heating that metal and letting it cool and the corresponding physical strength at that heat. Immense quantities of good metal have been spoilt in mill and shop on account of improper heat treatment, and while we know a little better to-day there is still a great deal to be learned on the subject, and our technical universities, who are doing already such good work in physical metallurgy, can be of great benefit to the engineer and our industries by thus contributing their mite to practical metallurgy. In answer to the question by the last speaker whether crystals are necessarily always formed by heat and are not likewise formed by shock and vibrations, I would say that experience seems to indicate that metals, that is iron and steel, do not crystallize under the influence of shock and vibrations as was commonly supposed formerly.

But while metals do not crystallize due to shocks and vibrations they undoubtedly become fatigued, and when thus fatigued, iron and steel break more easily, and because they break more easily when fatigued, they break more quickly under undue strains, and because breaking quickly the metal has no time to flow, its plasticity does not come into play, and if we succeed in breaking a metal before flow

sets in, we get a transverse section of the individual fibers which will give the fractured surface a crystalline or granular appearance, which is then assumed to be a crystallization due to shock and vibrations.

Thus, cause and effect are confounded; the crystalline fracture is assumed to be a cause, while the cause is the fatigue of the metal, which breaks more easily and quickly because it is fatigued, and because it breaks more quickly the plastic property of the metal does not come into play, flow will not take place, and because there is no flow the metal will break crystalline, and what we take for crystallization due to shock is nothing but the transverse section of the individual crystals or fibers of the metal thus broken. Under favorable conditions we can break the finest stay-bolt iron, so that it will show a so-called crystalline or, more properly expressed, a granular fracture. The condition is, that the vibrations set up by the blow or blows in the portion receiving the blow will not be transmitted to that portion from which the first portion is to be broken off, or, in other words, that the portion held in some manner while one end or portion is being broken off, is held so rigidly that the vibrations produced in the piece to be separated are not transmissible to the piece held. The aim and object must be to prevent flow of the metal, not to allow plasticity to come into play before fracture takes place. If shock and vibrations produce crystallization, then iron car-axles ought to crystallize sooner than any other structure; but I have come across iron car-axles which were sixteen, eighteen, twenty and one was twenty-one years in service, and they showed no sign of crystallization.

On the other hand, I have tested and examined 2-inch rods from old canal locks which never had been shocked by any manner of means, and yet they were largely crystalline, the reason for this being, that the iron was granular or cold-short when it was new, as is often the case, and when such a granular portion or nest of crystals happens to come in a location in the structure which has to carry the load, that structure is liable to break under a lower stress than was calculated for, because the structure is weakened

by the granular spot of iron imbedded in the fibrous mass, and thus we have a contributary cause to produce fatigue in the metal sooner than it ought to become fatigued and, as said previously, the structure will break more quickly because weakened by a streak or nest of originally crystalline iron, and because breaking quickly it will break without flowing.

First-class metal, breaking slowly by fatigue or, as we call it, breaking in detail, does not show any granular fracture at all, and I have examined such detail fractures with the microscope a number of times in iron and steel and never was able to detect any change in the structure of the metal more than an eighth of an inch at the point of fracture, and then the changed metal was of an amorphous structure and not crystalline, as it ought to be if there is anything at all in the crystallization theory by shock and vibrations.

Steel being crystalline to begin with, we cannot reasonably even speak of the crystallization of steel. In order for a metal to crystallize it must be a fluid solution like a salt-solution, for instance, or at least in a pasty state, and therefore the science of crystallization is opposed to the theory that crystals can form in a cold piece of metal of such a form and consistency as are formed in a solution according to the laws of crystallization. Crystals are the product of the solidification of chemical elements which are attracted toward each other while being held in a mobile state in the solution, according to the law of their affinities, whatever that law may be, and, moreover, the forces which tend to destroy a structure, or part of a structure, of whatever kind, are directly opposed to the formation of crystals, because strains and stress act upon a metal in the nature of work, and therefore these destructive forces tend to break up the structure, to make it smaller if large, or amorphous, silky, or velvety, if the structure was small from the beginning.

MR. ROBERT JOB: The question of the last speaker, whether iron becomes crystalline as a result of stresses in service, recalls a case which came under my observation a number of years ago. The end of a truss-rod upon a bridge

had broken, and the rod, which was of 1¼ inches rod iron, about ten feet long, had been thrown upon the ground, and had broken into three pieces, showing a coarsely granular fracture. The rod had been in position thirty years, and the theory was advanced that granulation and brittleness had resulted owing to continuous vibrations in service. Thinking that the conditions of the other rods might disprove this statement, we had several removed from the bridge from positions corresponding exactly with that occupied by the defective rod and subject to exactly the same stresses for the same length of time. Upon fracture, we found a long fibrous structure in each case, with tensile strength of about 48,000 pounds per square inch, and an elongation of 35 per cent. in a 2-inch section. In other words, the vibrations of thirty years' service had not caused any change from the original fibrous structure. Analysis next showed that the composition of these different bars was closely alike, as were the etched sections, and it seemed evident that the rods had been rolled from the same stock, and probably at the same time. Thus it was clearly shown that the coarse granulation had not resulted from the stresses of service, but that it had been present in the iron at the start, this condition being the result of defective heat-treatment in the manufacture.

The whole question of heat-treatment of metals is today receiving great attention, and as a practical result, great improvement in the quality of many products has been attained. As a case in point, we may cite the effect of heat-treatment upon the quality of steel rails, as shown by an investigation which has been in progress with us for some time. It was found that a rail of a given composition when finished at a yellow-heat was exceedingly brittle, and broke like glass under a single blow in the drop test. A rail of identically the same composition, but finished at a red color, withstood without fracture eight blows of a 2,000 pound weight falling a distance of 20 feet, the supports being 4 feet apart.

Sections under the microscope showed in the former case a very coarse granular structure, and in the latter a

much finer interlocking appearance, which amply accounted for the increased strength observed under the drop test. In service, similar differences would be observed as to wear, since it has been repeatedly proven by different observers that rapidity of wear varies—other things being equal—with the size of the grains of the metal. Thus, we have found that this mere difference in finishing, temperature has transformed a fragile untrustworthy rail into one of vastly increased toughness and ability to resist wear.

DR. JOSEPH W. RICHARDS (Lehigh University) begged leave to call attention to the information which might be gotten respecting the constitution of alloys by a consideration of the variation in other physical properties than the melting points. The specific gravity of alloys compared with their specific gravity calculated from that of their constituents, showed usually a contraction taking place during an alloying, sometimes an expansion. Dr. Mathews had shown that gold-silver alloys were peculiar in that their melting points varied regularly and uniformly from that of silver to that of gold. These very alloys are also peculiar in their specific gravities, which vary regularly from that of silver to that of gold without any expansion or contraction taking place at any point. The speaker had verified this fact many times by finding the specific gravities of gold-silver alloys exactly the same as that calculated from their composition. This absence of expansion or contraction in alloying seems to be, therefore, characteristic of alloys which are simply homogeneous mixtures and which form no eutectic alloy. Dr. Mathews had shown that 0·5 per cent. of aluminium in tin depressed the melting point of the latter, but over this amount the melting point rose, 1 per cent. having the same melting point as pure tin. While the speaker had not measured the specific gravities of these alloys, he felt confident in predicting that similar phenomena would be found in this respect, that 0·5 per cent. of aluminium in tin would probably be found to increase the specific gravity of the latter, instead of decreasing it; that above this amount would lose its effect, and that the alloy with 1 per cent. would probably be found to be of the same

specific gravity as pure tin. It is known that one-half per cent. of aluminium in iron *increases* its specific gravity. One per cent. of antimony in lead makes an alloy *heavier* than lead; 2 per cent. is of the same specific gravity as lead, and higher percentages are lighter. It is very likely that these alloys will show an analogous behavior in their melting points. Alloys are best studied by making a complete correlation of as many physical properties as can be observed, and such study is not only of high theoretical interest but of immediate practical value in the arts.

MONOCHROMATIC COATINGS ON GERMAN SILVER AND PLATINUM.

BY DR. R. BOETTGER.

After innumerable experiments success has been achieved in producing the finest monochromatic shades on platinum and German silver by electrolytic decomposition of organic manganous salts, the metal to be treated being connected with the positive electrode. It has formerly been supposed that it was principally the form of the negative pole that influenced the nature of the Nobili figures. Although this cannot be denied altogether—for with a sharply pointed platinum wire only ring-shaped figures can be obtained—yet the rule is subject to modification with regard to certain manganous salts. With solutions of manganous hippurate, acetate or succinate, even when a very thin platinum wire serves as the negative pole, colored rings are never formed, but a monochromatic coating, on the positive electrode. This has only been observed with these special salts. It further appears that metals which form higher oxides, such as lead and manganese, are the best in solution for producing Nobili figures. In using the special manganese salts for obtaining the monochromatic coating, the shape of the negative pole appears to be immaterial; but it is advisable to secure uniformity of the coating on the positive element, that the negative element should take the form of a disk of platinum. Nothing decided can be said about the strength of the manganese solutions, as the best strength depends upon the power of the current, and must be determined by each experimenter for his own special case. The weaker the current the stronger the manganese solution must be. The color produced changes greatly and quickly, so that it is essential instantly to break the current when the desired color has been produced. Golden yellow, green, and purple are obtained with particular brilliancy. The metal should be removed from the bath as soon as the current is stopped, rinsed with distilled water, and carefully dried with soft blotting paper. If manganous chloride or lead acetate is used, the colors appear in rings instead of as a uniform layer and of all the colors of the rainbow, in the softest shades, the predominant hues being green, golden yellow and blue, each whole system of rings surrounded by a yellow zone.—*Der Metallarbeiter.*

Section of Photography and Microscopy.

Stated Meeting, held Thursday, December 5, 1901.

ON THE REVERSAL OF THE PHOTOGRAPHIC IMAGE AND ITS SUBSEQUENT DEVELOPMENT IN ACTINIC LIGHT.

BY M. I. WILBERT,
Member of the Institute.

Prof. Francis E. Nipher, during the past year, presented several communications to the Academy of Science of St. Louis that have renewed the general interest in the subject of sensitive silver salts and their characteristic behavior to the action of actinic light. The peculiar fact that these silver salts have the property of assuming a certain physical condition that makes them particularly susceptible to the action of reducing agents, and also that an extended exposure to actinic light brings about a reversal of this peculiar physical condition, were facts that had been observed long before Professor Nipher made his interesting communications. The feature of his experiments that was original, and that was all that Professor Nipher claimed to be original, is the posibility of developing these reversed photographic images in actinic light.

The statement of this fact, when first made, appeared to be so different to what we were accustomed, in ordinary photography, that it created widespread attention, and caused numerous experiments to be made along the same lines.

Following up a suggestion that was made before the Photographic Section of the Franklin Institute some two months ago, I made several experiments along these same lines. These experiments appeared to me to be interesting, and to some extent also instructive. Professor Nipher, in one of his early communications, states that a photographic plate, even after it had been exposed for weeks to diffused daylight, would still give an image if exposed to the direct

spark discharge of an induction coil or a static machine, and subsequently developed, either in the dark room or in bright daylight,

To test this statement I allowed several pieces of damaged photographic plates to lay exposed to bright light for ten days or two weeks, and then subjected them to a spark discharge; the resulting electrographs were then developed in bright light, and, in each case, the resulting picture showed the action of the electric spark clearly. In one case, shown here, a coin was placed in the center of photographic plate and connected with one terminal of the induction coil. In the resulting picture we see plainly the radiations of the spark in all directions. The most interesting part of this particular experiment, however, is the fact that the area immediately under the coin and a very narrow zone around it has been completely reversed, while the spark radiations, with few exceptions, show dark against the fogged background of the plate itself.

Following up Professor Nipher's own experiments, I exposed a very sensitive photographic plate under a positive, in this case a dense lantern slide, for five minutes and then developed the same at a window with northern exposure, using an old metol-hydroquinone developer without any further restrainer. The resulting picture makes a presentable lantern slide, and represents fairly the condition of the original positive.

To get an idea of the length of time necessary to obtain the best results under similar conditions, I interposed between the plate and positive a piece of heavy black paper. By withdrawing this paper gradually, I was able to make on the same plate exposures of one, two, four and eight minutes. As will be seen by an inspection of this picture the portion of the plate that has not had any exposure under the positive is entirely opaque; that portion that was exposed for one minute is very dense, but the portions of the picture representing the deepest shadows in the original picture are not entirely reversed. The portion of the plate exposed for two minutes is next in density, and here we have complete reversal of all portions of the picture. The parts that were

exposed four and eight minutes respectively, are not nearly as dense and differ but little in their general appearance. This is a feature that should especially be noted, as it appears to me to be evidence of a protective influence of the upper layers of changed silver salts, similar to what we would naturally expect to have had in the plates that had been exposed to diffused daylight for weeks. This experiment was gone over on several occasions, with uniform results. Even in cases where the highest exposures were as long as an hour, or the equivalent of many hours' exposure in a camera, the high lights came out quite clear, barring the general vagueness that we see in all reversed pictures.

A series of exposures made with a camera were, however, of even greater interest to me showing, as they do, the very great range of exposure that is possible with rapid photographic plates under practically the same conditions of illumination and development.

The subject was Girard College in bright sunlight at or near mid-day. The first picture is a negative made with an exposure of approximately half a second, using a Beck wide angle lens having a 128 stop. The resulting picture developed with fresh normal metol-hydroquinone developer, came up to its present density in a little over four minutes after being placed in the developing solution and is, if anything, a little overexposed.

The next picture had exactly the same amount of exposure with a sixteen stop, giving it approximately eight times the amount of light of the first; the plate developed very much more rapidly, but is still a very fair negative.

The next one of the series was exposed for five seconds under exactly the same conditions as the previous one, using the sixteen stop, and the result is still a negative, though rather thin; but when we consider that it has had eighty times the light that the first negative had, we will appreciate that the possible range of exposure is really remarkable.

The next plate had an exposure of fifty seconds, and shows traces of general fog; you can see, however, that there are distinct traces of reversal; the high lights are

completely reversed and almost clear. This plate would probably come somewhere near the so-called zero condition, where the positive and negative conditions of the plate would nearly balance each other, and give as result of this a general fog.

Again increasing our exposure, this time to ten minutes, and developing the picture in the dark room, we obtained a completely reversed picture that is rather dense in the shadows on account of the activity of the developer; under these conditions, this plate did not require more than three minutes in the developing solution, and appeared to flash up very rapidly.

The next picture was given the same exposure, but developed at an unprotected window having a northern exposure —in fact, the same window from which the plate had been exposed in the camera. This required eight or nine minutes to develop, and the conditions of the development were quite different. When the plate was first taken from the camera there was plainly seen a distinct outline of the picture as a negative. On placing the plate in the developing solution this negative image gradually faded until the plate was perfectly blank, then the edges of the plate that had been protected by the holder began to darken, and following this the positive image gradually but slowly developed, the process requiring at least three times the time that was necessary in the dark room.

Some further experiments were made with a view of testing the action of various reducing agents; the exposure in these cases was twenty-five minutes, and more or less satisfactory results were obtained by using pyrogallic acid, amidol, eikonogen, metol, metol-hydroquinone, and hydroquinone as the reducing agents. The first four did not give very satisfactory results, as their action appears to be too rapid and rather irregular; the fifth was the developer used in the experiments alluded to above; while the sixth, hydroquinone, was used with and without an alkali, with interesting results. The first picture, which I show you, had the normal amount of alkali, as advised in the formula given by the manufacturer of the plates that were used. This plate shows up quite clearly and is quite black.

The next plate was developed with a developer having but half the amount of alkali, and, as you can see, it has a distinctly brown cast of color; it was also slower in development, although not markedly so.

The third plate was developed without the addition of any alkali, and presents a reddish-brown appearance in color, though sharp and distinct in all details of the picture. Speculation as to the principles involved in these processes are perhaps out of order, but it appears to me as though the action of light on sensitive silver salts was in the first stage a purely physical one, disarranging the equilibrium of the molecules of the silver salt and making them susceptible to chemical reducing agents; prolonged action brings about a chemical change that produces opaque metallic silver or a silver oxid, and this in turn protects the silver bromide molecules immediately below it from further action of light; the physical change is going on in other portions of the plate, and these in turn are susceptible of reducing by proper chemical agents, while the portion that has been acted on chemically is not. The change brought about by reducing agents is much more intense and opaque than is that produced by light, thus giving us a dark picture against a gray or hazy background. As evidence of this I would say that so far I have not seen any reversed pictures in which the highlights were represented by perfectly clear glass.

More evidence that the ultimate action of light is chemical is found in the faot that we may expose a plate under a negative for a sufficient length of time to produce the outlines of the picture distinctly, then fix the resulting plate in hyposulphite solution and still retain the faint outline of the positive, and this in turn may be intensified so as to be distinctly visible.

Under proper conditions we would no doubt be able to make photographic negatives in this way without the use of a dark room; that is, by first dissolving out the unchanged silver salts in a fixing bath and subsequently intensifying the very weak but distinct image remaining on the resulting plate.

BOOK NOTICES.

Water and Water Supplies. By John C. Thresh, Sc.D., etc. Third edition, revised and enlarged. Philadelphia: P. Blakiston's Son & Co., 1901. 8vo, pp. XV + 527.

This work treats of water, its composition and properties, rain and rain-water, surface water, subsoil water, natural spring waters, deep-well waters, river water, quality of drinking waters, impure water and its effects upon health, the interpretation of water analyses, the pollution of drinking water, the self-purification of rivers, the purification of water on the large scale, domestic purification, the softening of hard water, quantity of water required for domestic and other purposes, selection of sources of water-supply and amount available from different sources, the protection of underground water supplies and the protection of surface-water supplies, wells and their construction, pumps and pumping machinery, the storage of water, the distribution of water, the law relating to water-supplies, rural and village water-supplies, and water charges.

The work has an elaborate general index and an index of proper names. It is well illustrated.

Furnace Draft: Its production by mechanical methods. Wm. Wallace Christie, Consulting Engineer, etc. Published by the author. Paterson, N. J., 1901. 12mo, pp. 44. (Price, 50 cents.) D. Van Nostrand & Co., New York.

The author devotes this momograph to the consideration of the several methods of operating furnaces by mechanical means, by blowers, steam jets, etc.

Linear Drawing and Lettering. For beginners. By J. C. L. Fish, Assoc. M. Am. Soc. C. E., Associate Professor of Civil Engineering in the Leland Stanford Junior University. Published by the author. Palo Alto, Cal. 7 x 10½, oblong. V + pp. 65, 46 figures. (Limp cloth, $1.00.)

Chapter I treats of instruments and materials. Chapters II and III give the details of the course of "Linear Drawing and Lettering" in Stanford University; and Chapter IV treats of the details of draughting as pursued in the course of instruction followed in the University.

Franklin Institute.

[*Proceedings of the Stated Meeting held Wednesday, February 19, 1902.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, February 19, 1902.

President JOHN BIRKINBINE in the chair.

Present, 124 members and visitors.

Additions to membership since last report 12.

Dr. Joseph W. Richards, Bethlehem, Pa., presented an interesting informal communication on the "Electro-Chemical Industries at Niagara Falls," which he was requested to prepare for publication in the *Journal*. The remainder of the evening was devoted to the consideration of the report of the special committee appointed at the stated meeting of November 20, 1901, to consider the adoption of the metric system of weights and measures in the United States.

The report (with appendix) as submitted is as follows:

REPORT OF THE SPECIAL COMMITTEE APPOINTED BY THE FRANKLIN INSTITUTE TO CONSIDER THE FEASIBILITY AND ADVISABILITY OF THE ADOPTION OF THE METRIC SYSTEM IN THE UNITED STATES.

WHEREAS, It is desirable to obtain an international standard of weights and measures, also to simplify and regulate some of our existing standards; and

WHEREAS, The metric system is commendable, not only as a suitable international standard, but also for facility of computation, convenience in memorizing and simplicity of enumeration;

Resolved, That the Franklin Institute approves of any movement which will promote the universal introduction of the metric system with the least confusion and expense.

Resolved, That the national Government should enact such laws as will ensure the adoption of the metric system of weights and measures as the sole standard in its various departments as rapidly as may be consistent with the public service.

JAMES CHRISTIE,
American Bridge Company, Pencoyd, Pa.

A. E. KENNELLY,
Houston & Kennelly, Electrical Engineers.

F. E. IVES,
Photographer and Engraver.

WILFRED LEWIS,
President Tabor Machine Co.

S. M. VAUCLAIN,
Superintendent Baldwin Locomotive Works.

JESSE PAWLING, JR.,
Instructor in Physics, Central High School.

GEORGE F. STRADLING,
Instructor in Physics, N. E. Manual Training School.

HARRY F. KELLER,
Professor of Chemistry, Central High School.

A. FALKENAU,
Engineer and Machinist.

L. F. RONDINELLA,
Instructor in Engineering, Central Manual Training School.

January 22, 1902.

APPENDIX.

Questions discussed at meeting of Sub-Committee, January 17, 1902.

QUESTIONS.	Answers Agreed upon.
(1) Assuming the desirability of an international standard, could we expect nations using the metric system to abandon that and adopt our system?	No.

(2) Can we not concede the advantages of the metric system for purposes of computation, and also as being readily memorized and the relations between weights and measures borne in mind without much effort?	Yes.
(3) Have any valid objections against the metric system been effectively urged, excepting that the numeration cannot be continuously subdivided by two?	No.
(4) Is not this similar objection to our decimal currency overcome by the advantages of the system?	Yes.
(5) For convenient minimum units of hand rules, is not the mm. better than either $\frac{1}{10}''$ or $\frac{1}{32}''$, the latter being rather a fine subdivision for ordinary rough measurements?	The mm. is equally as convenient.
(6) Assuming that the change in our system could be effected, without serious expense or confusion, could we recommend this change as desirable?	Yes.
(7) Could not such a change be fairly initiated if the national Government would adopt the system in all its departments where no serious confusion would occur from an early change, gradually extending the system to other departments, when people became accustomed to its use, and tools were accumulated which conformed to the new standard?	Yes.
(8) In the workshops, could not a large proportion of existing tools and gauges be retained until they were gradually superseded, merely designating their nominal dimensions in the nearest convenient metric units?	We anticipate no prolonged serious confusion.
(9) If in the course of a term of years the system came into universal use in the service of the government, is it probable that its adoption would follow elsewhere within a reasonable time?	Yes.
(10) Would it appear to be practicable to inaugurate the adoption of the metric standards for weights or for liquid measures in advance of linear measures, as the former would not involve the abandonment of such numerous and costly tools as would the latter?	No.

The Secretary presented a large amount of correspondence from prominent manufacturers and professional men throughout the country whose opinions on the report had been solicited.

The discussion of this subject was then opened by Mr. George M. Bond, representing the Pratt & Whitney Company, of Hartford, Conn., who spoke in opposition to the committee's views.

Messrs. Vauclain, Christie and Pawling, of the committee, Dr. E. J. Houston, Mr. Spencer Fullerton and a number of others spoke in favor of the report.

After a protracted discussion, the report was adopted by a decisive majority.

(The discussion and important correspondence on the subject will shortly be published in the *Journal*.)

Adjourned.

WM. H. WAHL, *Secretary.*

SECTIONS.

(*Abstracts of Proceedings.*)

PHYSICAL SECTION.—*Stated Meeting* held Wednesday, January 22, 1902. Dr. Stradling in the chair.

The annual report of the Section's operations during the past year was thereupon presented and, after reading, was adopted and ordered to be transmitted to the Board of Managers.

The following were elected officers of the Section to serve for the ensuing year, viz.:

President—Dr. A. Stanley Mackenzie.

Vice-Presidents—Dr. Martin C. Lloyd, Dr. Geo. F. Stradling.

Secretary—Mr. Jesse Pawling, Jr.

Conservator—Dr. Wahl.

The Section tendered a vote of thanks to Dr. Stradling, its retiring President, for the admirable manner in which he had conducted the affairs of the Section during the past year.

The meeting thereupon proceeded to the consideration of a report of a Special Committee of the Institute on "The Feasibility and Advisability of the Adoption of the Metric System in the United States." The report was discussed by Messrs. E. Goldschmidt, G. A. Hoadley, A. S. Mackenzie, Geo. F. Stradling, and Jesse Pawling, Jr. On Dr. Stradling's motion the report was unanimously endorsed.

Dr. Jos. W. Richards, of Lehigh University, followed with the paper of the evening on the "Goldschmidt Theory of Harmony," after some discussion of which the meeting was adjourned.

JESSE PAWLING, JR.,
Secretary.

CHEMICAL SECTION.—*Stated Meeting* held Thursday, January 23, 1902. Dr. Williams in the chair. Present, 34 members and visitors.

The following were elected officers of the Section for 1902, viz.:

President—Lyman F. Kebler.

Vice-Presidents—Mr. Joseph Richards, Dr. R. H. Bradbury.

Secretary—W. E. Ridenour.

Conservator—Dr. Wahl.

The meeting passed a unanimous vote of thanks to the retiring President, Dr. Williams, for his services during the previous year.

Mr. Kebler then assumed the chair.

Dr. H. F. Keller presented for consideration the report of a Special Committee of the Institute on "The Feasibility and Advisability of the Adoption of the Metric System of Weights and Measures in the United States." On motion of Dr. H. W. Jayne, numerously seconded, the Section endorsed the report.

Dr. W. F. Hillebrand, U. S. Geological Survey, read the paper of the evening, on "Modern Methods of Analysis as Applied to Minerals and

Rocks," which was discussed by Mr. Kebler, Dr. H. F. Keller, Prof. L. F. Garrison, and the author.

The meeting passed a vote of thanks to the author and adjourned.

WM. H. WAHL,
Secretary pro tem.

SECTION OF PHOTOGRAPHY AND MICROSCOPY.—Proceedings of the fifteenth *Stated Meeting*, held Thursday, February 6th. Dr. Henry Leffmann in the chair.

The annual election at the previous meeting resulted as follows:

President—Dr. Henry Leffmann.

Vice-Presidents—F. E. Ives, J. W. Ridpath.

Secretary—Martin I. Wilbert.

Conservator—Dr. Wahl.

The report of the Special Committee appointed by the Institute at the November meeting to consider "The Feasibility and Advisability of the Adoption of the Metric System of Weights and Measures in the United States" was brought before the Section and unanimously approved.

The paper of the evening, on "Orthochromatic Photography," was presented by Mr. John Carbutt. The speaker illustrated the subject by photographs made on orthochromatic plates. The effects produced by color screens were also illustrated.

Mr. Ives expressed his satisfaction in finding that American manufacturers had taken up the manufacture of red sensitive plates.

The question of a safe light for a dark room was brought up, and Mr. Carbutt stated that a screen allowing but few of the extremes of red rays was the only one that was possible.

Dr. Leffmann referred to the very great use that was being developed for aniline dyes, not alone for dyeing purposes, but also in connection with scientific investigations, and latterly with color photography.

M. I. WILBERT,
Secretary.

MECHANICAL AND ENGINEERING SECTION.—*Stated Meeting* held Thursday, February 13, 1902. Mr. A. M. Greene, Jr., in the chair. Present, 48 members and visitors.

Mr. James Christie, chairman of the Special Committee of the Institute to report on "The Feasibility and Advisability of the Adoption of the Metric System of Weights and Measures of the United States," presented the committee's report and advocated its endorsement by the Section. (The report will be offered for approval by the Institute at the stated meeting of February 19th). The report was discussed by Messrs. Spencer Fullerton, J. C. Trautwine, Jr., Jesse Pawling, Jr., H. T. Colvin and others. The report was approved and the action of the Section was ordered to be transmitted to the Institute.

Mr. Walter Ferris presented a paper on "Water Meters," fully illustrated by lantern-slides.

Mr. Charles Day followed with a communication on "The Application of Motor Drives to Machine Tools," illustrated by numerous examples exhibiting the advantages derived from this mode of power transmission. Both papers were freely discussed.

D. EPPELSHEIMER, JR.,
Secretary.